



501293

DESIGN TECHNICAL MEMORANDUM

for the

**REMEDICATION OF IMPACTED SOILS
at the
GRANVILLE SOLVENTS SITE
GRANVILLE, OHIO**

Submitted to:

**The United States Environmental Protection Agency
Emergency Response Branch, Region V
Chicago, Illinois**

Developed for:

**Granville Solvents PRP Group
Columbus, Ohio**

August 31, 1995



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An Air & Water Technologies Company

August 31, 1995

Mr. Edward J. Hanlon, Project Coordinator
U.S. Environmental Protection Agency, Region 5
Office of Superfund, Remedial & Enforcement Response Branch
77 West Jackson Boulevard
Chicago, Illinois 60604-3590

**Subject: Submittal of Final Design Technical Memorandum for the
Remediation of Impacted Soils
Granville Solvents Site
Granville, Ohio**

Dear Mr. Hanlon:

Enclosed are two (2) copies of the Final Design Technical Memorandum (DTM) for the Remediation of Impacted Soils at the Granville Solvents Site. Responses to U.S. EPA and Ohio EPA comments on the DTM (provided by U.S. EPA on August 14, 1995) are attached to this transmittal letter. The original DTM document (dated July 6, 1995) has been revised to incorporate the comment responses.

If you have questions regarding any of the enclosed information, please contact Ben Pfefferle at (614) 469-3200 or me at (614) 890-5501.

Sincerely,

METCALF & EDDY, INC.

Gerald R. Myers
Vice President/Project Coordinator

Enclosures

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cc: B. Pfefferle, Chairman - GSS Steering Committee
M. Raimonde, M&E
M. Anastasio, U.S. EPA
S. Acree, U.S. EPA
F. Myers, Ohio EPA
D. Plunkett, Village of Granville

**RESPONSES TO COMMENTS ON THE JULY 6, 1995
DESIGN TECHNICAL MEMORANDUM
FOR REMEDIATION OF IMPACTED SOILS AT THE
GRANVILLE SOLVENTS SITE**

EPA's comments on the above are reproduced in bold type, followed by the PRPs responses in standard type.

COMMENTS PROVIDED BY MR. EDWARD HANLON - (Comments dated August 14, 1995)

1. **The 9/7/94 AOC requires that a site specific QA/QC plan (AOC section V.2.3) and a comprehensive sampling and analysis plan (AOC section V.2.c) be developed and submitted for review which discusses procedures to be followed for the sampling and analysis of all media to be studied at the site. While this issue was generally discussed at the 7/10/95 meeting, it has not yet been resolved. While a proposed general soils sampling location figure was provided in this document, it is EPA's understanding that no comprehensive QA/QC or sampling and analysis plans have yet been submitted for the soils media. Such plans are requested to be submitted for review prior to the conduct of the soils sampling effort. These plans should discuss, in part, the overall objectives and purposes for the sampling of the parameters, locations and depths of all sampling to be conducted and how these locations will meet the intent and objectives of this sampling effort, the SOPs for the various physical analyses planned, and SOPS for soil sample collection (including how the soil samples be collected and handled to minimize volatile loss).**

RESPONSE:

1. An updated Quality Assurance Project Plan (QAPP) for the Granville Solvents Site has been prepared and is scheduled for submittal to U.S. EPA during the week of August 21, 1995. The updated QAPP includes an Appendix A which provides details on field sampling procedures. The updated QAPP was prepared using the following U.S. EPA guidance documents: Interim Guidelines and Specifications for Preparing Quality Assurance Plans (QA-MS-005-80, December 1980); Data Quality Objectives Process for Superfund (EPA 540-R-93-071, Interim Final Guidance, September 1993); and Soil Sampling Quality Assurance Users Guide (EPA/600/58-59/046, March 1989). The objectives of the soil sampling and analysis plan are presented in Section 5.1 of the Design Technical Memorandum (DTM) and in Section 2.3.2 of the updated QAPP. As stated in these documents, the objectives of the soil sampling investigation are to provide physical and chemical data which will support the evaluation of candidate soil treatment technologies and ultimately assist in the preliminary design and implementation of a soil treatment remedy. The information included in the QAPP, along with the information provided in the DTM, will provide all of the requested information with the appropriate level of detail.
2. **A proposal for the determination of VOC and metals background concentrations in soils should also be provided within the soils sampling plan to be submitted, in part because the background concentrations may be higher than the "preliminary remediation goals" (PRGs) as presented in Table 3-5.**

RESPONSE:

2. A discussion of the plan to collect background samples to determine background concentrations of metals is included in Section 2.0 of the updated QAPP. In addition, Section 5.3 of the DTM has been revised to include information on the number and location of background samples. In general, the plan would include the collection of background samples from seven boring locations (three boring locations in the municipal well field, an additional three boring locations north of the site, and one boring location east of the site). Samples will be collected from the borings at intervals of 2-4, 6-8, 12-14 and 18-20 feet below ground surface. The samples will be analyzed for the 8 RCRA metals. The background samples will not be analyzed for VOC concentrations for several reasons. The first reason is that VOCs are not naturally occurring. Also, the presence of VOCs may be widespread throughout the site and surrounding area, which may make it difficult to differentiate site-related chemical concentrations from "background" anthropogenic or off-site source concentrations.
3. **Regarding the volatile organic contaminants (VOCs) soils PRGs for the site, the highest of the following concentrations would be acceptable cleanup levels to U.S. EPA for cleanup of VOCs within the Granville site soils, and are thus the maximum levels to be left on the site after site cleanup: a) the VOC PRGs provided in Table 3-6 of the Design Technical Memorandum; or b) background concentrations (only if GSSPRPs can demonstrate and provide an acceptable evaluation of background conditions at the site without industrial influences - to be determined after background sampling occurs). U.S. EPA expects that these concentrations will be acceptable to Ohio EPA, and will inform GSSPRPs as soon as U.S. EPA and Ohio EPA finalize discussions on this issue.**

RESPONSE:

3. It is agreed that the soil PRGs for VOCs will be the higher value of the soil PRG presented in Table 3-6 of the DTM or the background concentration determined for the site. However, it is not anticipated that background soil samples will be analyzed for VOC concentrations for two reasons. The first reason is that VOCs are not naturally occurring. The second reason is that the presence of VOCs may be widespread throughout the site and surrounding area, which may make it difficult to differentiate site-related chemical concentrations from "background" anthropogenic or off-site source concentrations.
4. **Regarding the metals and semi-VOCs soils PRGs for the site, U.S. EPA and Ohio EPA have agreed to defer decisions on metals and semi-VOCs soils PRGs until the sampling for metals and semi-VOCs in soils has occurred. GSSPRPs are requested to prepare a table similar to table 3-5 for all of the metals and semi-VOCs constituents to be analyzed for, and submit this table as well as a summary table similar to Table 3-6 for metals and semi-VOCs parameters to U.S. EPA and Ohio EPA for review at the time the results of sampling are submitted for review.**

RESPONSE:

4. The text on page 6 has been revised to indicate that the chemicals of concern include those constituents which have been detected to date, and that additional chemicals may be added to the text based on any additional soil sampling investigations that occur at the site. Revisions to Tables 3-5 and 3-6 will be made at the time any additional chemicals have been detected during the additional soil investigations. These tables will then be submitted to the Ohio and U.S. EPA for review.
5. **Regarding the VOCs groundwater PRGs for the site, U.S. EPA and Ohio EPA have agreed that the concentrations provided in Table 3-6 are acceptable VOCs groundwater PRGs for the site, with the following comment, it is acceptable that these concentrations are the MCLs if available, and if no MCL is available then the PRG refers to the SPA Region 3 and 9 PRGs. However, for a few of the PRGs listed, GSSPRPs should clarify whether the intent was to use a comma vs. a decimal point, and if so, to amend the table accordingly.**

RESPONSE:

5. It is agreed that the VOC groundwater PRGs as listed in Table 3-6 of the DTM are acceptable PRGs for the site. However, as site-specific data become available, the groundwater PRGs may be revised to reflect site conditions, and not be based on U.S. EPA default PRGs. Table 3-6 will be revised to show that the number contains a comma, not a decimal point.

Response to comment requesting an update on the status of approval from Ohio EPA of the Interim Action discharges to Raccoon Creek.

Attached is a copy of a letter from the OEPA Assistant Chief of the Division of Surface Water dated June 8, 1995 stating that an NPDES permit is not required for cleanup activities at the Granville Solvents Site.

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COMMENTS PROVIDED BY MR. STEVEN ACREE - (Comments Dated August 7, 1995)

1. Section 3.4, p. 10-12

It is of general concern that the report has titled this section *Site-Specific*. The majority of the PRGs presented in this document are taken directly from the December, 1994, *DRAFT Soil Screening Guidance* (or, *Guidance*) document, without comparison or clarification of the site conditions matching the generic conceptual site used in the development of generic SSLs. The Guidance states that these values are generic SSLs, and stresses the methods for developing site-specific, SSLs. These methods include the use of site-specific values for the parameters in the general equations, or by the use of more detailed fate and transport models. There may be a considerable difference between generic and site-specific numbers. It is recommended that the report discuss the reasonableness of the generic conceptual model for application to this site.

The generic conceptual site used for the development of the SSLs presented in the *Guidance* is defined by:

- ✓ Contaminant source being from the surface to the ground-water table, which is stated in the Guidance as being a reasonable assumption for sites with the depth to ground water being approximately 5-10 feet;**
- ✓ Contaminant source area being approximately 30 acres, and for sites larger than 30 acres the DAF would decrease, and vice versa;**
- ✓ No attenuation is considered in the unsaturated zone;**
- ✓ The point of compliance is at the edge of the site;**
- ✓ The assumption is made that the aquifer is unconfined and unconsolidated with homogeneous and isotropic hydrologic properties; and**
- ✓ NAPLs are not present.**

As noted above, the document should provide a discussion of how the site-specific conceptual model can be described by the generic conceptual model. It must be remembered that these values are presented to be very conservative, and with the intent that the PRP would pursue a more detailed evaluation of the site-specific conditions and their impact on contaminant fate and transport. Overall, the suggested PRGs would appear to be relatively low for the major contaminants of concern at this site. The proposed plan has taken very conservative values, and proposed them for PRGs, potentially, without consideration of the intended use of these generic values.

RESPONSE:

- 1. The DTM text has been revised by omitting "Site-specific" and providing a better description of site-specific risk-based PRGs versus generic SSLs. The generic SSLs have been used as a conservative measure until site-specific data has been collected. As the text states on page 12 of the DTM, the development of the conceptual site model (CSM)**

is an iterative process which results in changes as additional site-specific information is obtained. Soil to groundwater modeling may then be performed utilizing site-specific physical soil parameters (e.g., TOC, soil moisture, bulk density, etc.) that would provide more representative fate and transport processes for the site. In addition, the text has provided, on page 12, the generic conceptual site used for the development of the generic SSLs and the relationship between the generic SSLs and the site-specific CSM.

As noted on page 12 of the DTM, the use of default-based or generic SSLs provides the most conservative level of protection to the potential human and environmental receptors without the use of site-specific information. As additional site information is obtained, the generic SSLs will be revised to incorporate site data.

2. Section 3, Figure 3-1

It is not clear how a contaminant can move from the soil into the ground water without going through the leaching pathway. Even water and contaminant movement through preferential vertical paths would be considered a leaching mechanism. The document does not state the physical process represented by this pathway. If there exists a mechanism such as this, it would further invalidate the use of the *Guidance*, and possible result in even lower acceptable PRGS. It would also result in a very difficult sampling plan for a statistical comparison of the PRGs with actual site contaminant concentrations.

RESPONSE:

2. The figure incorrectly depicts the soil to groundwater relationship. Figure 3-1 has been revised such that the arrow pointing directly to groundwater from soil has been removed.

3. Section 4.1-1, p. 18

The plan briefly discusses potential use of pneumatic fracturing to increase permeability of site soils and facilitate treatment using soil vapor extraction. Future, more detailed evaluations of this technology should not that induced fracturing may be of limited value in decreasing contaminant concentrations outside the immediate vicinity of the fractures. This technology may result in some initial increase in contaminant mass removal but may not be sufficient to treat soils to proposed action levels.

RESPONSE:

3. As stated on page 18, the DTM text acknowledges that additional evaluation of technologies which may increase the permeability of the site soils (including pneumatic fracturing) is necessary. Please note that pneumatic fracturing may be employed using fracture points that are closely spaced (2 feet apart or less) which may result in overlapping fracture zones throughout the site. Furthermore, it should be recognized that under U.S EPA's Superfund Innovative Technology Evaluation (SITE) program, the combination of SVE and pneumatic fracturing has successfully increased contaminant mass removal several thousand percent and nearly tripled the vacuum radius of influence of the extraction wells when compared with SVE treatment alone. In addition,

enhancements to the combined pneumatic fracturing/SVE treatment may also be considered to further increase contaminant mass removal with this treatment process.

4. **Section 4.1.2, p. 19**

Soil flushing is briefly discussed in this section and in Table 4-2. As noted in this table, flushing of contaminants into the saturated zone upgradient of the municipal well system may not be desirable. It should also be noted that some contaminants in soils may exist as nonaqueous phase liquids. These liquids may be mobilized by flushing agents and migrate to greater depths. Under this scenario, environmental problems may be exacerbated.

RESPONSE:

4. As stated on page 19 and in Table 4-2 of the DTM document, the potential side effects of the soil flushing technology are recognized. It is recognized that without hydraulic control in the vicinity of the soil flushes, this technology may pose containment challenges.

5. **Section 5.0, p. 20-25**

The document does not discuss a statistical method proposed for comparison of contaminant concentration data with the PRGs. It is recommended that the document discuss the proposed methodology for comparison and determination of soil volumes/locations for remediation.

RESPONSE:

5. The text has been revised on page 24 of the DTM to describe that the comparisons of the proposed PRGs with chemical concentrations in soil will be made in order to define the locations of areas above and below the PRG level. For defining areas or locations that are above or below a certain PRG level, the use of a statistical comparison would not be appropriate.

6. **Sections 5.2 and 5.3, p. 21, 22**

Although analyses proposed in these sections provide basic information required for evaluating the applicability of potential remedial technologies, few details of the plan were provided for review. Sampling and analysis procedures were not discussed in detail nor were methods referenced. It is recommended that such information be included. Potential soil sampling techniques designed to minimize loss of volatile constituents are discussed in a recent Issue Paper entitled *Soil Sampling and Analysis for Volatile Organic Compounds*.

RESPONSE:

6. An updated Quality Assurance Project Plan (QAPP) document for the Granville Solvents Site has been prepared and is scheduled for submittal to U.S. EPA during the week of August 21, 1995. (See response to Mr. Hanlon's comment #1.) The updated QAPP includes Appendix A which provides details on field sampling procedures, including

sampling techniques designed to minimize the loss of volatile organic constituents that may be present in the soil samples.

7. Section 5.2, p. 21

The plan proposes to obtain samples for these analyses from two different locations within each of three geologically different areas. The proposed boring locations and sampling depths were not stated. In general, samples should be obtained from the same soils that will ultimately be remediated. It should also be noted that these properties may be highly variable within each of the different areas. A total of two samples from each area will provide little information concerning this variation.

RESPONSE:

7. The above-referenced updated QAPP for the Granville Solvents Site describes the collection and analysis of physical soil data. Where applicable, the sample intervals chosen for physical soil parameters will be consistent with the intervals proposed for the chemical soil analysis (i.e., 2-4 feet, 6-8 feet, 12-14 feet, and 18-20 feet below ground surface). The DTM has been revised to include these sample intervals and specify the sample locations. Samples will be collected from the three distinct geological site areas, all of which have the potential to have been impacted by site industrial activities. This proposed plan for the collection of physical soil data will result in a total of 24 data points (4 from each of the six boring locations) at the site. Based on the relatively small size of the Granville Solvents Site, this plan should provide sufficient information regarding the variability of the physical parameters of the site soils which may affect the remedial design.

8. Section 5.2, p. 21

One of the parameters to be analyzed is termed "Biodegradation Confirmation." No description of the actual analyses is provided in this section or in Table 5-1. Much more information would be required for an independent evaluation of the applicability of the data that may be obtained from this analysis. It should be noted that biological transformation of the chlorinated solvents found at this site is generally considered an area of continuing research. It is also noted that analyses for total organic carbon are proposed. Depending on the ultimate use of this information, data from analyses of samples not contaminated with site-related organic compounds may also be required.

RESPONSE:

8. With respect to the physical soil data collection plan presented in Section 5.2 of the DTM, please note that the list of physical analyses has been modified. The revised list of physical parameters is presented below:

22.
10.
9.
gr.
- 1) Particle Size Analysis
 - 2) Atterburg Limits
 - 3) USCS Classification
 - 4) Specific Gravity

- 5) Moisture Content
- 6) Total Organic Carbon
- 7) Cation Exchange Capacity
- 8) Eh
- 9) Bulk Density
- 10) Soil pH
- 11) Flexible Wall Permeability Test

This revised list of physical parameters has been developed to satisfy current and future site data needs. These data may be used to evaluate the feasibility of treatment technologies, evaluate soil contaminant transport, and support future revisions to the soil PRGs based on site-specific information.

As indicated by the revised list of physical soil parameters presented above, biological parameters (including biodegradation confirmation and bacterial enumeration) have been eliminated as proposed tests. These tests were removed from the list because biological treatment is considered one of the least promising candidate treatment technologies for the impacted soils at the Granville Solvents Site because of the high clay content of the site soils and the presence of a variety of chlorinated and non-chlorinated organic species would complicate the biological treatment process. For information only, the biodegradation confirmation test is a microcosm study whereby the reduction of organic contaminant concentrations in soil compared to abiotic controls are monitored over time to determine if biodegradation of soil contaminants is occurring.

Although testing for biological parameters is not being proposed at this time, it is recognized that additional site data may indicate that biological treatment warrants further consideration. In addition, it is acknowledged that biological treatment of chlorinated organic compounds in soil is an issue of continuing research that may ultimately result in scientific developments and breakthroughs. Therefore, it should be noted that testing for biological parameters may be performed at the Granville Solvents Site in the future. In the event that this type of testing is proposed, a plan for performing the tests will be submitted to the regulatory agencies for review.

With respect to the total organic carbon (TOC) analysis issue, it is anticipated that the samples analyzed for TOC will include some samples that are impacted with site-related organic compounds and others that are not impacted. Furthermore, it is acknowledged that, dependant upon the ultimate use of the physical soil data, analytical data from soil samples that are not contaminated with site-related organic compounds may be required.

9. Section 5.2, p, 21

It is recommended that soils from borings located in highly contaminated areas be continuously screened for indications of nonaqueous phase liquids. Soils contaminated with such liquids would represent the most contaminated materials at the site. Screening methods which have been applied in the field include use of a photoionization detector and soil/water separation tests enhanced using hydrophobic dye. Such methods are described in Cohen and others, 1992 (*Ground Water Monitoring Review*, v. 12, no. 41 132-141).

RESPONSE:

9. Section 5.3 - Chemical Soil Data Collection Plan - Page 25 of the DTM has been modified and includes a discussion of the plans to use fluorescence, centrifugation, and the addition of hydrophobic dye to assist in identifying non-aqueous phase liquids in the soil samples. A detailed description of this screening method is included in the revised QAPP for this project, scheduled for submittal during the week of August 21, 1995

10. Section 5.3, p- 22

The plan proposes interval sampling of soils from ground surface to the water table. It is suggested that sampling continue for some depth below the water table. The contaminants at this site were probably released as dense nonaqueous phase liquids. Such liquids may have migrated below the water table. Any nonaqueous phase liquids that currently reside in the saturated zone would represent a long-term source for continued ground-water contamination. Additional sampling below the water table may provide information for refining the conceptual model regarding locations of ground-water contamination sources at this site. Such information may impact evaluation of potential remediation technologies for the vadose zone. However, it is recognized that migration of such liquids through the subsurface may be highly complex and impractical to define in detail in a heterogeneous setting. A practical approach to consider is to continue to sample saturated zone soils in borings where contaminants are detected at concentrations significantly above action levels at the water table.

RESPONSE:

10. The Ohio EPA reported (see Appendix B of the Compliance Solutions, Inc. 1992, Granville Solvents Interim Action) PID and OVA measurements collected during the installation of on-site and off-site monitoring wells. Generally, where detected by these instruments, VOC concentrations are recorded at their highest 5 to 10 feet below the water level in the monitoring well and the readings decline rapidly with depth to near zero. In each of the cases, groundwater collected from that well was determined to be impacted with VOCs. Based on these data, two soil samples will be collected from below the water table encountered in each boring. Samples will be collected from a depth of 3-5 feet and 8-10 feet below the encountered water table. These samples will be screened for the presence or absence of free-phase non-aqueous phase liquids (NAPLs) as discussed in Section 5.3 of the DTM and described further in the updated QAPP. The screening procedure will use fluorescence, centrifugation, and the addition of hydrophobic dye to identify NAPLs.

11. Section 5.3, p. 23

Previous soil sampling results indicate the area contaminated at concentrations greater than the potential action levels (Table 3-6) may extend beyond the area proposed for sampling. It appears that additional sampling may be required to define the limits of this contamination.

RESPONSE:

11. As stated on page 24 of the DTM, the proposed soil sampling investigation will be performed in two phases. In the event that analytical data from the first phase of the sampling investigation indicates that impacted soils may extend beyond the proposed sample area (see Figure 5-1), the second phase of the sampling investigation will be planned accordingly. Please note that the analytical data presented in Table 2-1 and Figure 2-4 of the DTM supports the preliminary determination that the proposed sample area for the first phase of the sampling investigation should include all soils which exceed the soil PRGs noted in Table 3-6. Furthermore, please recognize that the analytical data presented in Figure 2-3 of the DTM represents heated head space analysis results (which were collected with the intent that they be used as a screening tool) with concentrations reported in parts per billion volume (ppbv) and cannot be compared directly with the PRGs noted in Table 3-6.
12. **Appendix A, Section 2-0, p. A-3**

The soil-water partitioning coefficients used to estimate potential remediation goals were derived using literature values for fraction of organic carbon in subsurface materials. In general, there is greater uncertainty in use of literature values for parameters rather than site-specific data. Site-specific data for organic carbon fraction at the depths of interest or studies to define the partitioning coefficients may be used to refine these estimates. However, it is noted that proposed remedial action levels are relatively low for the primary constituents of concern (e.g., trichloroethane). Differences in proposed goals due to refinement of these estimates may not significantly affect choice of remedial technologies or soil volumes.

RESPONSE:

12. It is agreed that greater uncertainty is associated with the use of literature values for parameters. The text has been revised on page A-3 of Appendix A to state that the fate and transport equation used to represent soil-to-groundwater migration does not provide a definitive, in-depth analysis of the complex fate and transport processes in the subsurface environment of GSS. The text further explains the assumptions made for this modeling approach. As additional soil physical parameters are obtained, the PRGs will be revised to reflect site conditions as applicable, which may or may not significantly affect the PRG levels.

COMMENTS PROVIDED BY DR. LUANNE VANDERPOOL - (Comments dated July 31, 1995)

1. Page 5, Third Paragraph

Briefly explain how soil samples were collected. What was the basis for selecting the eight samples that were duplicated and submitted for off-site laboratory analysis?

RESPONSE:

1. The soil samples were collected using a direct push technique (Geoprobetm). The basis for selecting 8 soil samples and submitting them to an off-site laboratory for analysis was to confirm the "hits" that the Close Support Laboratory detected and to provide some off-site laboratory data to compare and evaluate with the Close Support Laboratory data. These sample analysis results (both the Close Support and off-site laboratory) were obtained with the intent that they be used as a screening tool to assist in the development of subsequent sampling investigations. These data provided assistance in the development of the soil sampling program presented in the DTM.

2. Page 9, Soil Action Levels

It needs to be clear that the USEPA Soil Screening Levels (SSLs) are not action levels. A SSL is the chemical concentration in soil that represents a level of concentration below which (provided the conditions associated with the SSLs are met) there is no concern under CERCLA. Levels above the SSL don't automatically trigger a response action; exceeding a SSL suggests further evaluation to determine if a response action is appropriate.

In the discussion of EPA's SSLs, there needs to be an explicit statement and explanation of the assumed DAF (dilution and attenuation factor) of 10.

There is reference to Table 3.5; this table includes highlighted boxes. The text should state here the basis for selecting the boxes for highlighting.

RESPONSE:

2. The text has been revised on page 9 and 10 of the DTM to state the SSLs are soil screening levels, not action levels. In addition, the text reads that SSLs represent concentrations in soil that generally provide for the protection of human health in a residential setting and are not enforceable standards. Page 12 of the DTM presents the conceptual site used for development of the generic SSL DAF. The use of a DAF of 10 assumes a 30 acre size of contamination, the soil contamination extends from the surface to the top of the aquifer, no attenuation is considered in the unsaturated zone, the point of compliance is the edge of the site and contamination is assumed site-wide, an unconfined, unconsolidated aquifer with homogeneous hydrologic properties, and non-aqueous phase liquids are not present.

The basis for selecting the highlighted boxes is stated on page 10 of the DTM. The highlighted values on Table 3-5 represent the soil PRG proposed for the site. These

values are protective of chemical migration from soil to groundwater. The soil PRG is the lower of the values of the U.S. EPA or U.S. EPA Region III SSL. If a SSL was not listed for a chemical, the U.S. EPA MCL-based level is utilized as the PRG.

3. Page 11, Third Paragraph

There is reference in the 6th line of this paragraph to U.S. EPA and U.S. EPA Region III soil action levels. The U.S. EPA levels are Soil Screening Levels, not action levels.

RESPONSE:

3. The text has been revised on pages 11 and 12 to correct the statement that the U.S. EPA levels are soil screening levels, not action levels.

4. Page 21, Physical Soil Data Collection Plan

Where/what are the SOPs for the various physical analyses planned? What exactly is biodegradation confirmation; does this involve microcosm studies?

RESPONSE:

4. The updated QAPP includes an appendix which provides field sampling procedures for the physical soil analyses that are planned. Please note that the list of physical parameters presented in Section 5.2 has been revised and no longer includes testing for biological parameters, including biodegradation confirmation. For information only, the biodegradation confirmation test is a microcosm study whereby the reduction of organic contaminant concentrations in soil compared to abiotic controls are monitored over time to determine if biodegradation of soil contaminants is occurring. Additional information presented in the response to comment Number 8 from Mr. Steven Acree of U.S. EPA should also be referred to in response to this comment.

5. Page 22, Chemical Soil Data Collection Plan Fourth Paragraph

What are the implications for soil if it is considered "impacted"?

Please give the rationale for the selected depths (2 to 4, 6 to 8, 12 to 14, and 18 to 20 foot intervals) for soil sampling.

Figure 5.1 shows the proposed sampling plan and delineates the "impacted soil area". There needs to be a direct way to compare this figure with the analytical results shown in Figure 2-3. This might be accomplished by plotting the figures at the same scale (for easy overlaying) , or by showing previous soil sampling locations on Figure 5.1.

RESPONSE:

5. Based on previous soil sampling in the area of the warehouse and former tank farm, these soils are suspected to be impacted with compounds formerly processed at the site; it is anticipated that the soils in this area may require some type of remediation. The

DTM text has been revised to state that the chemical data which result from the implementation of the DTM sampling plan will be compared with PRG concentration levels to establish which of the site soils contain contaminants which exceed the PRG levels. An exceedance of the PRG levels will be an indication that the soils in these areas require further evaluation to determine if a response action is appropriate. In addition, the chemical data will assist in the evaluation, selection, development, and design of a treatment remedy for the impacted site soils. Based on the understanding that the soils in the warehouse and former tank farm area are most likely impacted and may require remediation, extensive sampling of this area is considered unnecessary. Designating this area as "impacted" should not be interpreted to indicate that impacted soils are not present adjacent to or outside this area at the Granville Solvents Site. The text on page 24 of the DTM has been revised to clarify this issue.

The noted soil sampling intervals (2-4 feet, 6-8 feet, 12-14 feet, and 18-20 feet below ground surface) were selected with the understanding that, as stated above, the resulting analytical data will facilitate the identification of site soils with chemical concentrations that exceed the PRG values and ultimately assist in the evaluation, selection, and design of a treatment remedy for the impacted soils. Based on professional judgement, the distribution of soil data that will be achieved with the prescribed sample intervals is considered reasonable and will provide the data necessary to identify impacted soil areas and estimate impacted soil volumes as required for treatment remedy implementation.

Please refer to the explanation above regarding the "impacted soil area" and the response to comment 11 from Mr. Steve Acree of U.S. EPA which explains that the analytical data presented in Figure 2-3 of the DTM represents heated head space analysis results with concentrations reported in parts per billion by volume (ppbv). These data were collected for screening purposes only. Based on this information, a direct comparison of the data presented in Figure 2-3 and the proposed sample locations presented in Figure 5-1 may not be appropriate. Nonetheless, the scale on Figure 5-1 has been revised to be consistent with the Figure 2-3 scale.

6. Page 23, First Paragraph

The text here is confusing. Will the sampling at the three locations in the impacted area be done at the same time as the sampling at the 24 locations in the "first phase"?

This first phase of sampling does not appear to be sufficient to identify "clean" areas. Will future sampling have the objective of identifying and confirming where soil levels attain clean up standards?

RESPONSE:

6. The sampling at the three locations in the impacted area will be conducted at the same time as the sampling at the 24 locations outside Area A in the "first phase". The DTM text has been revised to clarify this issue. The DTM text on page 23 now states that the first phase of the sampling investigation will entail the collection and analysis of soil samples from 27 boring locations (24 locations outside Area A and 3 within Area A).

The DTM text has been revised to clarify that the second phase of the soil sampling investigation will be developed using the soil data from the first phase to refine the locations of impacted soil areas of the site. The data from the first phase will be used to determine if a given grid area has been impacted. Based on the identification of impacted grids, the objective of the second phase will be to further refine the site soil areas that contain contaminants above or below the PRG levels. The response to comment 5 above should be referred to for additional information concerning this issue.

7. Page 23, Second Paragraph

Which of the sampling locations shown in Figure 5-1 will be samples for TCL semi-volatiles and the 8 RCRA metals? The figure does not identify the locations. Outside the "impacted area" what is the rationale for the selection of the 5 out of 11 sampling locations for these analyses?

Where is the SOP for soil sample collection? How will the soil samples be collected and handled to minimize volatile loss?

RESPONSE:

7. Samples from the three boring locations inside Area A (the area designated as "impacted") will be analyzed for TCL semi-volatiles and the 8 RCRA metals. It is expected, that within the area designated as impacted, that there is the highest probability of detecting elevated concentrations of RCRA metals or SVOCs if they are present. The DTM text on page 24 and Figure 5-1 have been revised to specify the location of all samples to be analyzed for SVOCs and metals.

As noted in the response to comment number 1 above from Mr. Edward Hanlon of U.S. EPA, an updated Quality Assurance Project Plan (QAPP) for the Granville Solvents Site has been prepared and is scheduled for submittal to the U.S. EPA during the week of August 21, 1995. The QAPP includes an Appendix which provides details on field sampling procedures, including sampling techniques designed to minimize the loss of volatile organic constituents that may be present in the soil samples.

8. Table 3-6

The sentence which is the second footnote does not make sense. Please correct.

RESPONSE:

8. The footnote on Table 3-6 has been revised to read: The groundwater PRG is the U.S. EPA maximum contaminant level (MCL). If an MCL is not available, then the PRG is the lower value of the U.S. EPA Region III and Region IX risk-based groundwater values (provided in Tables 3-2 and 3-3 of the text).

9. Figure 2-3 and 2-4

There seem to be inconsistencies between these two figures. Is SS19 in Figure 2-4 a duplicate of SS22 in Figure 2-3? Is SS20 in Figure 2-4 a duplicate of SS6 in Figure 2-3?

RESPONSE:

9. The locations of samples SS19 and SS20 on Figure 2-4 were inaccurately located. Figure 2-4 has been revised in the DTM to make the sample locations consistent with the sample locations on Figure 2-3.

10. Appendix A, Page 2, Last Paragraph

It is stated that the PRGs were derived based upon use of a predictive fate and transport model to characterize the potential for soil to groundwater migration of chemicals. Please specify the model (and give a reference) .

RESPONSE:

10. The PRGs that consider soil to groundwater migration have been derived based on a fate and transport model by Karickhoff (1979). The reference to this modeling technique has been added to the reference list. The model description is presented on the page A-3 of Appendix A.

11. Appendix A, Page 3, Second Paragraph, Last Sentence

The use of a Dilution and Attenuation Factor (DAF) as has been done here, does consider dilution and attenuation within the saturated zone.

RESPONSE:

11. The text on page A-3 of Appendix A has been revised to read that the use of a dilution and attenuation factor (DAF) in determining soil screening levels does consider the physicochemical factors of dilution and attenuation within the saturated zone (U.S. EPA, 1994). The DAF of 10 used here, however is a default value. Once the site-specific soil parameters have been obtained, the DAF may be adjusted to reflect site conditions which may alter the PRGs shown in this Appendix.

12. Appendix A, Page 3, Equation 1

This equation creates confusion. The equation includes K_{ow} , the octanol water partition coefficient; while Tables 20 and 21 list K_{oc} the soil organic carbon/water partition coefficient.

RESPONSE:

12. The equation in the text on page A-3 has been changed to include K_{oc} and exclude K_{ow} .

13. Appendix A, Page 4

The second paragraph on this page cites an EPA publication, "Determining Soil Response Action Levels Based on Potential Contaminant Migration to Ground Water" with a publication year of 1980; the correct year is 1989.

RESPONSE:

13. The date of the EPA reference has been changed from 1980 to 1989.

14. Appendix A, Page 4, Equation 4

Omitted from this equation is the use of a DAF as was included in your calculations in Tables 20 and 21 of this Appendix. Incorporate in the text a discussion on the use of the DAF.

RESPONSE:

14. The text has been revised on page A-4 of Appendix of the DTM to incorporate an explanation of the default DAF of 10.

OHIO EPA COMMENTS - MYERS - 8/8/95

1. Page 5, Top of Page

Split spoon samples were not sent to a US EPA contract laboratory. They were analyzed in field laboratory. These values should only be used for reconnaissance purposes.

RESPONSE:

1. The DTM text on page 6 and Table 2-1 have been revised to indicate that the samples were analyzed in a field laboratory and that the OEPA has suggested that these data be used for reconnaissance purposes only.

2. Section 3.0, Risk Based Preliminary Remediation Goals (PRGs), Page 6.

The text does not state precisely how PRGs will be used at this site. Since the status of this sight might still be considered a "removal action," a precise statement may not be necessary. We would like to discuss this issue so that we are aware of how final clean-up levels will be determined.

RESPONSE:

2. The text has been expanded to state the purposes of the PRGs. In addition, the text also notes that the PRGs may not be definitive as yet. Site-specific soil parameters will be obtained during future soil sampling events. These parameters will then be incorporated into the PRG derivations, resulting in more site-specific PRGs.

3. Page 6, Section 3.1, Chemicals of Concern (COCs).

This section states that COCs have been determined and are limited to the 22 volatile organic compounds in Table 3-1. The Ohio EPA is not prepared to agree with this list of potential COCs. The current data set for soil is incomplete, that is, very little inorganic and semivolatile data exists and no background soil data exists. Also, close support laboratory data should not be used to eliminate COCs. In our opinion, additional soil samples need to be collected before a final list of COCs can be generated.

RESPONSE:

3. The text has been revised on page 6 of the DTM to state that the list of chemicals of concern provide in Table 3-1 contains volatile organic compounds that have been detected to date. Based on the results of future sampling events, additional chemicals may be added to the list of potential COCs.

4. Page 8, Potentially Exposed Populations

The potential trespasser scenario should be considered because of the proximity of the residential areas to the site. Also, the potential for residential future use exists.

RESPONSE:

4. The text has been revised to read that because residential homes are located in the surrounding areas of the site, trespassing onto the site is not an unlikely event. However, no indications of trespassing (e.g., vandalism, debris, etc.) were observed on-site by M&E personnel during sampling events and site visits. In addition, the high perimeter fence serves as a deterrent for potential trespassers. It is also anticipated that any exposure a potential trespasser would incur would be limited and of short duration, similar to that of an on-site environmental investigation worker exposure. Therefore, it will be assumed that the risk associated with an environmental worker would encompass the exposure associated with a potential trespasser. The PRGs for the environmental investigator participating in sampling activities were determined conservatively by assuming no personal protective gear would be worn.

The potential for future on-site residential development of the GSS is highly unlikely for several reasons. The area is located in a flood plain and has limited space available for redevelopment purposes. The presence of the water treatment plant and bridge overpass would most likely prevent any residential type of redevelopment of the site. In addition, the site is located on land that has been zoned for industrial use. Future plans to rezone the area do not currently exist, and zoning for industrial use will continue into the future. Therefore, the potential of exposure to chemicals of concern for an on-site future resident does not exist and will not be included as a potential receptor for the GSS.

5. **Page 9, Soil Action Levels.**

The Ohio EPA has not adopted US EPA soil screening levels or soil action levels as ARARs.

RESPONSE:

5. The text has been revised on page 9 and 10 of the DTM to state that SSLs are to represent concentrations in soil that are protective of human health, and are not enforceable standards.

DESIGN TECHNICAL MEMORANDUM

FOR THE REMEDiation OF IMPACTED SOILS AT THE GRANVILLE SOLVENTS SITE GRANVILLE, OHIO

Submitted To:

**The United States Environmental Protection Agency
Emergency Response Branch, Region V
Chicago, Illinois**

Developed for:

**Granville Solvents PRP Group
Columbus, Ohio**

Prepared by:



**Metcalf & Eddy, Inc.
2800 Corporate Exchange Drive, Suite 250
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August 31, 1995

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1.0 INTRODUCTION

The objective of this Design Technical Memorandum (DTM) is to present an overview of the current plans to address the impacted soils at the Granville Solvents Site (GSS). This DTM includes a summary of GSS background information and available soil data, presents risk-based preliminary remediation goals (PRGs) for contaminants in the site soils, provides a preliminary evaluation and screening of candidate remedial alternatives for the impacted soils, and presents a plan for the collection of additional site soil data which will assist in the evaluation, analysis, and design of a remedial alternative for the GSS soils. The information and plans presented in this DTM were prepared with the intent that they will ultimately satisfy the remediation requirements for the GSS soils as stated in the September 1994 Administrative Order by Consent for the GSS.

The development of risk-based PRGs for the GSS soil contaminants (see Section 3.0) and the preliminary evaluation of candidate GSS soil treatment alternatives (see Section 4.0) are two fundamental tasks which will support subsequent GSS source area soil project tasks. The PRGs were used to assist in the screening and evaluation of candidate treatment alternatives for the GSS soils and will ultimately be used to develop cleanup goals for contaminants in the GSS soils. It is important to note that the PRGs presented in this DTM were developed with the understanding that, as additional site-specific information becomes available (i.e., site-specific analytical data), the PRG values will be adjusted or revised as appropriate. Furthermore, the preliminary evaluation of candidate soil treatment alternatives serves to eliminate numerous technologies and remedial actions based on technical feasibility, site-specific conditions, and cost considerations and allows future project tasks (i.e., plans for the collection of additional site soil data) to be developed and prepared with a focus on the most promising of the treatment alternatives.

2.0 SUMMARY OF SITE BACKGROUND INFORMATION AND SOIL DATA

2.1 BACKGROUND INFORMATION

The GSS is located at 300 Palmer Lane in Granville, Licking County, Ohio. Granville Solvents, Inc. (GSI), operated as a petroleum bulk storage, distribution, and recycling facility in Granville, Ohio, at this location from 1958 until approximately 1980. The facility handled petroleum-related products such as aviation fuels and antifreeze. In 1980 or earlier, operations changed to recycling and reclaiming solvents under a RCRA Part A Permit. GSI ceased operations after failure to obtain a RCRA Part B Permit. In 1990 and 1991, the Ohio EPA removed storage tanks and drums from the Site and installed and sampled groundwater monitoring wells. Analytical results indicated that groundwater was impacted with chlorinated hydrocarbons in the vicinity and west of the GSI property.

The GSS is situated on alluvial terrace deposits at the northern edge of the Raccoon Creek Valley. The valley is underlain in places by up to 200 feet of unconsolidated sediment consisting of predominantly sand and gravel outwash with varying amounts of silt and clay. The GSS is directly underlain by unconsolidated sediments consisting of clay, silt, and sand deposited on the Raccoon Creek Floodplain. These soils are characterized by a very low permeability. Bedrock in the valley and surrounding uplands consist of sandstone, siltstone, and shale. The water table is at an average depth of 20 to 22 feet below the ground surface at the GSS.

Located approximately 650 feet west of the property is one of three Village of Granville water production wells. In the last quarter of 1993, chemical analysis of groundwater collected from a monitoring well located approximately 450 feet east of the Village production well indicated that dissolved chlorinated hydrocarbons were present. In early January 1994, the Ohio EPA recommended that the Village of Granville remove this well from service to potentially reduce capture of the impacted groundwater. The Village of Granville complied with this request.

2.2 ADMINISTRATIVE ORDER BY CONSENT INFORMATION

Based on the preliminary findings of the Ohio EPA, the U.S. EPA identified the Potentially Responsible Parties (PRPs) who allegedly shipped solvent-type material to the GSI facility for recycling, consistent with GSI's Ohio EPA RCRA Part A Permit. In January 1994, the U.S. EPA proposed that the PRPs execute an Administrative Order by Consent (AOC) with the U.S. EPA. A group of the PRPs

voluntarily formed a group called the Granville Solvents Site PRP Group (PRP Group) in February 1994, and employed Metcalf & Eddy, Inc., in March 1994 to begin site work to collect data necessary to design and implement Removal Actions. Certain members of the PRP Group and the U.S. EPA voluntarily signed the AOC in September 1994. The AOC includes requirements for the project site:

- 1) By December 20, 1994, a groundwater extraction treatment system shall be installed and operational. The treatment system shall halt the migration of groundwater contamination (originating from the site) toward the Village of Granville municipal wellfield.
- 2) Implement the appropriate actions necessary to ensure that any contaminated water (originating from the site) that enters the Village of Granville municipal wellfield drinking water supply meets all risk-based and applicable federal and state drinking water standards.
- 3) The groundwater treatment system shall treat all groundwater within the contamination plume originating from the site to no further action levels which assure protection of human health and the environment and attain all risk-based standards and federal and state applicable or relevant and appropriate requirements (ARARs). The groundwater treatment system shall continue to operate (and the treatment system performance monitored) until the AOC is terminated.
- 4) Site soils shall be treated to levels which will assure protection of human health and the environment, to levels which will attain all risk-based standards and federal and state ARARs, and to levels which will assure, to the maximum extent practicable, that no groundwater beneath the soils will become contaminated above the groundwater no further action levels.

2.3 GROUNDWATER TREATMENT SYSTEM INFORMATION

In December 1994, a groundwater pump and treat system was installed at the GSS to collect and treat impacted groundwater beneath the site. The groundwater treatment system consists of two extraction wells (GSS-EW1 and GSS-EW2) equipped with submersible pumps, a low profile air stripper, transfer pumps, and transfer piping. Figure 2-1 (attached) provides an illustration of the extraction well locations and representative groundwater potentiometric surface conditions during operation of the treatment

system. The groundwater potentiometric surface conditions illustrated in Figure 2-1 provide evidence of the control and capture of groundwater beneath the GSS and the resulting control of contaminants present in the site groundwater. Pumping rates for extraction wells GSS-EW1 and GSS-EW2 averaged 200 gpm and 90 gpm respectively from the commencement of system operations in December 1994 through mid-February 1995. Pumping rates for each extraction well averaged 90 gpm from mid-February through mid-April. Based on influent and effluent analysis results from the groundwater pump and treat system, an estimated 60 pounds of organic compounds were removed from the site groundwater between mid-December 1994 and mid-April 1995.

2.4 SAMPLING INVESTIGATIONS AND SOIL DATA

To date, some limited soil sampling activities have been conducted at the GSS to assist in identifying the nature and extent of site soil contamination. The soil data resulting from these sampling investigations indicates the presence of volatile organic compounds (VOCs) in the site soils, particularly chlorinated hydrocarbons including tetrachloroethene (PCE), trichloroethene (TCE), trichloroethane (TCA), dichloroethene (DCE), and dichloroethane (DCA). The highest concentrations of these contaminants have been observed in the immediate vicinity of the warehouse building. Based on available site data, the soil contaminant concentrations appear to decrease with distance from the site buildings and are limited to the GSI property. Contaminants were detected in the soils at depths ranging from just below the ground surface (2 to 4 feet) to immediately above the water table (generally 20 to 22 feet below the ground surface). The following paragraphs provide a summary of the soil sampling investigations performed at the site.

In June 1991, Compliance Solutions, Inc. was retained by the Ohio EPA to install several groundwater monitoring wells and collect and analyze soil samples from the GSS. A total of 14 monitoring wells were installed between June 1991 and May 1992. Soil cuttings from the boreholes used to install the monitoring wells were monitored using a photoionization detector (PID) during this investigation. Soil samples were also collected from some of the boreholes using a split spoon sampler. These samples were analyzed in a field laboratory for volatile organic compounds (VOCs). Ohio EPA has suggested that these analytical results be used for reconnaissance purposes only. Figure 2-2 provides the monitoring well locations for this investigation. Table 2-1 provides the soil results for the samples that were analyzed in the field laboratory for VOCs. Attachment A of this DTM provides the available boring logs (including PID readings) for this investigation.

In addition to the soil sampling and analysis activities associated with the installation of site monitoring wells, the contractor retained by the Ohio EPA collected a soil sample from a sump located in the northeast corner of the warehouse building (18-inch depth) and three soil samples near the northwest corner of the warehouse building (3-, 20- and 26-foot depths). The soil sample from the sump was analyzed for VOCs, semi-volatile organics, pesticides, herbicides, metals, and cyanide. The soil samples from the northwest corner of the warehouse building (location MW-P1 on Figure 2-2) were analyzed for VOCs. Tables 2-2 and 2-3 provide the analytical results for the constituents detected in these soil samples.

Additional soil sampling at the GSS was performed by M&E under the direction of the PRP Group in April and May of 1994. During this investigation, a total of 48 soil samples were collected and analyzed by M&E's Close Support Laboratory which employed a heated headspace analysis to determine the presence of PCE, TCE, TCA, and DCE. In addition, 8 of these samples were duplicated and submitted to an off-site laboratory and analyzed for VOCs (by U.S. EPA Method 8020) for confirmation purposes. Figures 2-3 and 2-4 provide an illustrative summary of the analytical data resulting from this sampling investigation.

In addition to the sampling and analysis of the site soils, M&E also conducted three soil vapor removal (SVR) pilot tests at the GSS to evaluate the soil permeability and the potential for removing VOCs from the site soils by simply applying a vacuum. The SVR test results indicated that the site soils have a very low air permeability in the locations that were evaluated.

3.0 RISK-BASED PRELIMINARY REMEDIATION GOALS

This section of the DTM presents health-based preliminary remediation goals (PRGs) derived for chemicals in soil and groundwater for the GSS. PRGs are concentrations or levels for chemicals of concern which serve as criteria for evaluating site conditions as to the nature and extent of contamination, volume of impacted site soils, etc., or as long-term targets for selection of remedial alternatives in environmental investigations. The PRGs are also determined on a chemical- and media-specific basis.

It is important to note that this memorandum is limited to the development of health-based or risk-based PRGs. The ultimate cleanup level or objectives for a chemical may not be based strictly on risk considerations. There may be cases where the risk-based PRG is below: 1) the level to which currently available remedial technologies can decrease chemical concentrations, 2) the level which can be detected with any confidence by analytical laboratories, and/or 3) the level which could be achieved within a reasonable time frame or cost. As the soil sampling investigation continues, and site-specific data are obtained, the cleanup levels will ultimately be established. In the interim, the intended focus is to present the methodology for the PRG determination and selection process.

Development of the PRGs entails the identification of chemicals of concern, development of a site conceptual model, identification of Applicable or Relevant and Appropriate Requirements (ARARs), and ultimately, calculation of risk-based chemical concentrations. The PRGs will provide a basis for identifying the target chemical concentrations in soil and groundwater which would be the goal of the remedial technologies applied at the site.

3.1 CHEMICALS OF CONCERN

The chemicals of concern were identified based on the general types of chemicals described in the Administrative Order of Consent (AOC) for the site, the analytical results of historical sampling of groundwater and soil, and sampling and analyses of soil and groundwater performed by Metcalf & Eddy, Inc., in 1994. As indicated in Table 3-1, the chemicals of concern to date are limited to 22 volatile organic compounds (VOCs) which have been detected in soil and/or groundwater. As the field initiative continues and additional sampling and analyses are performed, additional chemicals detected in soil and/or groundwater may also be considered for designation as chemicals of concern.

3.2 CONCEPTUAL SITE MODEL

The conceptual site model (CSM), shown in Figure 3-1, was developed to present an understanding of the site dynamics for use in the preparation of health-based PRGs. The CSM also delineates important fate and transport processes. In general, the CSM provides a presentation of the matrix of potential chemical sources and migration pathways, routes of exposure, and receptors potentially subject to exposure to chemicals in the environmental media at the GSS. The CSM focuses on complete exposure pathways. For an exposure pathway to be complete the following components must all be present: a source, a release mechanism, a transport medium, an exposure point, and a receptor.

Exposure pathways describe the movement of chemicals from sources to media where exposed populations (receptors) could potentially come in contact with the chemicals. Exposure routes describe the modes of contact and intake of chemicals in environmental media at exposure points. For example, trichloroethene in the soil (the source) at the Granville site could be encountered or uncovered during drilling or excavation activities and released as a vapor (through a volatilization release mechanism) into the air (the transport medium). The air containing the trichloroethene could then be breathed by the driller or excavator (through inhalation at the exposure point). This is a hypothetical scenario and such exposure pathways would be prevented through Health and Safety Practices enforced at the site. However, the example is illustrative of how the CSM is developed to characterize how exposures or contact with site-related chemicals might occur.

The development of a CSM is an iterative process which can result in changes in the model as site-specific information is obtained. It should be noted that development of the conceptual site models has been based only on information available to date from the site. These data indicate that the two primary sources of chemicals at the Granville site are chemicals in soil and chemicals in groundwater.

The human populations, individuals, or receptors who could feasibly be exposed to chemicals from the site are key to the process of developing risk-based PRGs. Risk-based PRGs ultimately should reflect the chemical concentration which will be protective of the receptor populations. The potential receptors of concern for the Granville site include:

On-Site Environmental Investigation Workers

Individuals who participate in sampling activities (such as drillers or environmental workers) could feasibly come into contact with chemicals in soil or groundwater. However, these workers are trained

to avoid such contact and must take protective measures and wear protective equipment and clothing to prevent chemical exposures. It would be expected that such sampling would not require more than one week per quarter over at least one year, but probably for an indeterminate number of years. It should be noted here that the PRGs for the environmental investigation worker who participates in sampling activities were conservatively derived by assuming personal protection gear would not be worn.

On-Site Excavation Workers

Individuals may come onto the site to perform excavation activities and could feasibly come into contact with chemicals in soil. However, these workers are trained to avoid such contact and must take protective measures and wear protective equipment and clothing to prevent chemical exposures. Further, the workers could perform digging activities in machinery with enclosed operator cabs and purified/filtered ventilation systems which would be further protective against exposure. It would be expected that such work would occur on an intermittent basis.

Off-Site Bikeway User

Individuals utilize the bikeway adjacent to the Granville site for walking, jogging, biking, etc. Because the site premises are enclosed by a fence, the bikeway users cannot enter onto the property. Therefore, the only feasible means for potential exposure would be through contact with chemicals emitted as vapors from site soils. Such exposure would be expected to be very short in duration because the bikeway segment at the site is limited to the length of the southern boundary of the site.

Off-Site Resident

Individuals live in homes located to the north, northeast, and northwest of the Granville site. Because the site premises are enclosed by a fence, the residents cannot enter onto the property. Therefore, the only feasible means for potential exposure would be through contact with chemicals which have been emitted as vapors from site soils or which have migrated off-site in groundwater. Because residential homes are located in the surrounding areas of the site, trespassing onto the site is not an unlikely exposure scenario. However, no signs of trespassing were observed on-site by M&E personnel during site visits. In addition, the high perimeter fence serves as a deterrent for potential trespassers. It is also anticipated that any exposure a potential trespasser would incur would be limited and of short duration, similar to that of an on-site environmental investigation worker. Therefore, the risk associated with an environmental investigation worker would encompass the exposure associated with a potential trespasser.

The potential for future on-site residential development of the GSS is highly unlikely for several reasons. The area is located in a flood plain and has limited space available for redevelopment. The presence of the water treatment plant and bridge overpass would most likely prevent any residential type development of the site. In addition, the site is located on land that has been zoned for industrial use, and is bounded on the east and west by industrial property and on the south by a no-build zone adjacent to Raccoon Creek. Future plans to rezone the area do not currently exist, and zoning for industrial use will continue into the future. Therefore, the potential of exposure to chemicals of concern for an on-site future resident does not exist and will not be included as a potential receptor for the GSS.

3.3 ARARS REVIEW

ARARs for chemical release sites include cleanup standards, standards of control, and other enforceable federal, state and local environmental regulations and requirements for environmental protection. These standards and requirements may specifically address a hazardous constituent, remedial action, location, or other circumstances at a site. As such, ARARs are categorized as follows:

- Chemical-specific requirements
- Action-specific requirements
- Location-specific requirements

Drinking Water ARARs and Action Levels

Chemical-specific ARARs for the site are primarily limited to U.S. EPA Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) for drinking water and Ohio EPA MCL standards for public water supplies. A summary of the MCLs for the chemicals of concern which have been developed by U.S. EPA and Ohio is provided in Table 3-2.

U.S. EPA Regions III and IX have developed generic risk-based action levels or PRGs for chemicals in drinking water. A summary of these action levels is provided in Table 3-3. The U.S. EPA Region III and IX PRGs are derived based on a generic residential use scenario.

Soil Screening Levels

For direct contact with chemicals found in soils, U.S. EPA has developed draft Soil Screening Levels (SSLs) for some of the chemicals of concern. SSLs represent concentrations in soil that generally provide for the protection of human health in a residential setting. SSLs are not enforceable standards. These

SSLs are generic for residential exposure to soils. In addition, risk-based soil levels have also been developed by U.S. EPA Regions III and IX for residential and occupational exposure to soils. A summary of the various U.S. EPA soil PRGs for the chemicals of concern to date is provided in Table 3-4.

Finally, U.S. EPA and U.S. EPA Region III have also derived SSLs for soil which are targeted to be protective of groundwater. These soil levels were developed with the goal that release of chemicals from soil to groundwater would not result in chemical concentrations which would be higher than risk-based drinking water concentrations. A summary of the SSLs is provided in Table 3-5. The highlighted values on Table 3-5 represent the soil PRGs proposed for the site. These values are protective of chemical migration from soil to groundwater. The soil PRG is the lower value of the U.S. EPA and U.S. EPA Region III SSL. If a SSL was not listed for a chemical, the U.S. EPA MCL-based level is utilized as the PRG.

3.4 RISK-BASED PRELIMINARY REMEDIATION GOALS

Site-specific PRGs for the chemicals of concern identified to date in soil have been calculated. The derivation of such PRGs is based on achievement of a specific criterion for noncancer hazard and carcinogenic risk endpoints. The potential for noncarcinogenic effects is evaluated by comparing exposure level estimates to toxicity levels developed by U.S. EPA (below which noncancer effects would not be expected/predicted to occur). The criterion for noncancer effects should be such that the ratio between estimated exposure (relative to site-related chemical concentrations) and the associated U.S. EPA-developed toxicity value does not exceed unity. For carcinogenic effects, the criterion is based on the estimated probability for cancer development. For exposure to chemical carcinogens at sites where hazardous substances have been released, U.S. EPA's NCP requires that estimated lifetime cancer risk at a particular site should fall within the range of 1 in 10,000 (1E-04) and 1 in 1,000,000 (1E-06). Similarly, the Ohio EPA's "How Clean is Clean Policy" adopts similar guidelines, stating that acceptable exposure levels are generally concentrations that represent a cumulative excess upper bound lifetime cancer risk to an individual between 1E-04 and 1.0E-06.

Chemical concentrations in environmental media which are associated with noncancer hazard levels of unity and carcinogenic risk levels of 1E-06 can be computed in much the same manner as the generic U.S. EPA residential and occupational action levels described in the ARARs Review, the U.S. EPA has published guidelines for the development of such PRG concentrations; these guidelines serve as the

primary basis for calculating the soil concentrations associated with specific health-related criteria (Human Health Evaluation Manual, Part B: "Development of Risk-Based Preliminary Remediation Goals", OSWER Directive 9285.7-01B, December 13, 1991).

Development of the PRGs requires the selection of the maximally exposed receptors identified in the CSM. A description of the equations and the assumptions utilized for the parameter values in the calculation of the human health PRGs for soil is provided in Appendix A. Soil PRGs were based primarily on oral and/or inhalation exposures. Current guidelines do not provide for the development of PRGs for dermal exposure to soil. The PRGs were calculated on an exposure-specific and a chemical-specific basis. A target risk level of $1.0\text{E-}06$ risk was used for each carcinogenic endpoint. Similarly, a target hazard quotient of 1.0 was employed for each chemical in the calculation of PRGs for non-cancer endpoints. The chemical-specific toxicity factors utilized in the derivation of the soil PRGs and the resulting PRGs for the oral, inhalation, and combined oral and inhalation exposure routes are also provided in Appendix A.

Table 3-5 provides a summary of the site-specific risk-based PRGs calculated for the chemicals of concern at the Granville site. The PRGs were calculated for direct contact exposures for the two primary on-site human receptor populations, namely potential excavators of site soils and environmental samplers. The two primary off-site receptors examined were residents of the homes in the vicinity of the site and pedestrians/bike riders who may traverse the portion of the bikeway which is located adjacent to and along the length of the site.

Additionally, PRGs were developed to provide protection from groundwater assuming that chemicals in soil have the potential to migrate to groundwater. The PRGs calculated for groundwater protection are also provided in Table 3-5. These PRGs for soil were developed with the goal that release of chemicals from soil to groundwater would not result in chemical concentrations which would be higher than U.S. EPA MCLs or U.S. EPA Region IX health-based groundwater concentrations. Risk-based preliminary remediation goals (PRGs) have been determined for the GSS site based on site-specific information if possible, or if not, conservative default, or generic, parameters. Appendix A describes the methodology used to derive the U.S. EPA MCL-based and U.S. EPA Region IX-based soil to groundwater PRGs.

In addition to the site-specific PRGs, the U.S. EPA and U.S. EPA Region III soil screening levels (SSLs) for the protection of groundwater are presented for comparison purposes. It should be noted that these SSLs are derived to prevent chemical migration which would exceed risk-based rather than MCL-based

groundwater concentrations. In all cases, the SSLs have been derived assuming conservative default leach-based fate and transport processes which do not incorporate site-specific information. The SSLs are conservatively derived by incorporating a dilution and attenuation factor (DAF) of 10, which assumes the following points are true for the site:

- A 30-acre area is the size of contamination;
- Soil contamination extends from the surface to the top of the aquifer;
- No attenuation is considered in the unsaturated zone;
- The point of compliance is at the edge of the site, and contamination is assumed uniform throughout;
- An unconfined, unconsolidated aquifer with homogeneous hydrologic properties is present; and
- Non-aqueous phase liquids (NAPLs) are not present.

The primary uncertainties associated with the development of the PRGs lie in the populations which may be exposed and the fate and transport processes for chemicals in soil and groundwater. As mentioned in Section 3.2, the CSM (Figure 3-1) was developed to present an understanding of the site dynamics for use in the preparation of the PRGs. The development of the CSM is an iterative process which may result in changes as additional site-specific information is obtained. As site-specific information is obtained, groundwater modeling can be performed utilizing site-specific parameters (e.g., TOC, soil moisture, bulk density, etc.) that would provide more representative fate and transport processes. With respect to the potentially exposed populations, the environmental workers represent a population whose exposure would be expected to be limited. With respect to potential future soil to groundwater migration, use of the default-based or generic U.S. EPA SSLs provides the most conservative level of protection without the use of site-specific information. However, as additional site-specific information is obtained, and the dynamics of the CSM become more focussed, site-specific SSLs can be derived for the site, which will be as conservative as the generic SSLs. At present, minimal off-site migration of chemicals is expected through air emissions pathways. Therefore, it is not anticipated that more restrictive soil levels would be required. The site-specific information such as air monitoring information or dispersion modeling would be helpful in further substantiating the assumption of minimal off-site chemical emissions.

3.5 SUMMARY OF PRGs DEVELOPMENT

Risk-based PRGs were developed in this section. The PRGs will be used in the evaluation and selection of remedial technologies for soil and groundwater at the GSS. Risk-based PRGs are levels in soil and

groundwater which would protect any individuals who could come in contact with site soils and groundwater from adverse health effects. The goal of this evaluation was to identify the population group that could have the most contact with site soils and groundwater and the PRGs which would protect these individuals from adverse health effects. Environmental workers (involved in sampling or excavation activities) will likely be the only population group who will have access to the site in the future and come into contact with site soil. People who would use groundwater for drinking water are likely to have the most contact with chemicals in groundwater. Finally, chemicals in soil could be transferred into groundwater which ultimately is used for potable purposes (such as for drinking water, bathing/showering, cooking, etc.).

The site-specific risk-based soil PRGs which were derived for the receptor groups identified for the GSS are provided in Table 3-5. Table 3-5 also provides the soil levels which are protective of soil to groundwater migration. A comparison of the two types of PRGs has been performed to determine the soil level which will be most protective of human health. The soil levels highlighted on Table 3-5 represent the PRGs proposed in Table 3-6. As mentioned earlier in Section 3.3, the soil PRG proposed for the site is the lower value of the U.S. EPA and U.S. EPA Region III SSL. The U.S. EPA MCL-based level was selected if an SSL was not listed in U.S. EPA guidance.

Soil and groundwater levels which will be health protective for people who might use untreated groundwater for drinking water are summarized in Table 3-6. The PRG evaluation showed that a potential movement of chemicals from soil to groundwater results in the lowest PRGs for soil. PRGs to protect workers from direct contact with chemicals in soil would be higher than the PRGs for chemical transfer from soil to groundwater. The soil PRGs which are protective of groundwater are the lowest values derived by the U.S. EPA as soil screening levels. The groundwater PRGs are maximum contaminant levels (MCLs) or, for chemicals for which MCLs are unavailable, the lowest risk-based PRG for drinking water. As site-specific data become available, the groundwater PRGs may be revised to reflect site conditions, and not be based on U.S. EPA default PRGs.

This discussion identifies ranges of potential receptor populations, exposure assumptions, and fate and transport factors which must be considered in selecting the appropriate remediation strategy for the site. A primary concern is how the site will be controlled and used in the future. The PRGs represent the highest levels which could be considered for the site. If more extreme assumptions about exposed populations or chemical fate and transport are of issue, the PRGs would likely be lower for some or all of the chemicals.

3.6 REFERENCES

U.S. EPA. 1995. U.S. Environmental Protection Agency. Drinking Water Regulations and Health Advisories. Office of Water. April 1995.

U.S. EPA. 1991. U.S. Environmental Protection Agency. Human Health Evaluation Manual Part B: "Development of Risk-Based Preliminary Remediation Goals." OSWER Directive 9285.7-01B. December 13, 1991.

U.S. EPA. 1993. U.S. Environmental Protection Agency. Drinking Water Regulations and Health Advisories. Office of Water. May 1993.

U.S. EPA. 1989. Risk Assessment Guidance for Superfund. Human Health Evaluation Manual. Part A. OSWER Directive 9285.7-01a. September, 1989

4.0 EVALUATION OF CANDIDATE SOIL TREATMENT ALTERNATIVES

This section of the DTM has been prepared to provide an evaluation of treatment alternatives for the impacted soils at the GSS. This evaluation is considered preliminary at this time, and will be revised as appropriate based upon the collection of additional data at the GSS. The evaluation presented below is based on available site data (see Section 2.0 of this DTM) and the preliminary remediation goals (PRGs) which have been developed for the site soils (see Section 3.0 of this DTM).

4.1 TREATMENT ALTERNATIVE EVALUATION

Lists of both established and innovative treatment technologies have been developed for the impacted soils at the Granville Solvents site. Tables 4-1 and 4-2 provide a preliminary screening of these technologies based on anticipated effectiveness (i.e., will the technology achieve the PRGs for the site soil contaminants), technical feasibility, and site-specific conditions. The screening comments in Tables 4-1 and 4-2 provide the specific rationale used to retain or eliminate a given technology or remedial action. The noteworthy advantages and disadvantages associated with each technology or action are also noted in Tables 4-1 and 4-2. As noted in Tables 4-1 and 4-2, a wide range of site remedies, including capping without treatment, in-situ treatment, ex-situ treatment, and off-site disposal with or without treatment were considered as a part of the remedial alternative evaluation process. When the cost of remediation is considered, in-situ treatment technologies would be preferred over ex-situ technologies based on the costs associated with excavation, materials handling, and disposal or replacement of the excavated soils. Furthermore, the higher cost of ex-situ treatment and off-site disposal alternatives provides justification for the expenditure of additional capital to collect additional site data and perform treatability studies to evaluate in-situ treatment technologies (including innovative technologies) which, if deemed technically feasible, may result in effective cleanup at a substantial cost savings. Based on the results of the preliminary screening of candidate treatment technologies presented in Tables 4-1 and 4-2, the following established remedies and innovative remedies have been retained for further consideration for the impacted soils at the Granville Solvents Site:

ESTABLISHED REMEDIES

- Capping
- Off-Site Disposal
- Bioremediation
- Soil Vapor Extraction

INNOVATIVE REMEDIES

Enhanced Volatilization
Low Temperature Thermal Desorption
In-Situ Mixing/Steam Stripping
Soil Flushing

The following sections provide a description of the established and innovative remedial alternatives which have been retained for possible application to the site soils. It should be noted that all innovative technologies and bioremediation and soil vapor extraction would require the performance of site-specific treatability study tests to provide the data necessary to evaluate thoroughly the potential effectiveness of these technologies.

4.1.1 Established Remedies

Capping

Capping is a remedial action which serves to prevent surface water from collecting and transporting contaminants through soil and into the underlying groundwater. Capping also reduces the potential for direct physical contact with contaminated soils. Capping is most appropriate for sites where contamination is extensive and excavation or treatment is unrealistic due to technical infeasibility, potential hazards to humans, or prohibitively high costs.

Various designs can be used to construct a cap and cover system over areas which contain contaminated soil. Common cap designs include those which comply with RCRA requirements for hazardous waste landfill covers (RCRA Subtitle C) and those which comply with state requirements for non-hazardous solid waste landfill covers. Other more simple designs may include a layer of low-permeability clay with a vegetative cover, concrete, or asphalt. All cap and cover systems will require long-term maintenance to ensure the continued effectiveness of the cap and cover system in reducing surface water infiltration and reducing the potential for direct physical contact with contaminated soils.

Off-Site Disposal

Hazardous Waste Landfill

This remedial action would entail excavating the impacted site soils with heavy construction equipment and disposing of the untreated soils at a hazardous waste landfill. Hazardous waste landfills are designed and operated in accordance with the standards established by the Resource Conservation and Recovery Act (RCRA). Implementation of this technology is restricted by increasingly stringent regulatory controls. Based on available analytical results for the site soils, RCRA land disposal restrictions may apply to some of the site soils. Land disposal restriction would require that the soils be treated prior to off-site disposal at a hazardous waste landfill.

Solid Waste Landfill

This remedial action has been retained for consideration as a possible follow-on component for soils that may be excavated and treated on-site. Disposal of treated soils at a solid waste landfill is a widely practiced remedial action component. However, the potential presence of residual contamination in the site soils, the increasing demand for solid waste landfill space, and the fact that the soils to be disposed will have originated from a CERCLA site are issues which will make solid waste landfill disposal of the site soils very difficult from an administrative standpoint.

Bioremediation

Bioremediation is a treatment technology that may be used to treat organic contaminants in soil. Bioremediation technologies involve enhancing the biological degradation of organic contaminants through the stimulation of indigenous microbial populations or through the addition of natural microbial species. Typical *ex-situ* bioremediation technologies include:

- Slurry-Phase Treatment
- Land Treatment
- Contained Solid-Phase Treatment

Slurry-phase bioremediation involves mixing excavated soil with water to create a slurry that is mechanically agitated in a treatment vessel (e.g., a tank) and mixed with the appropriate combination of

nutrients and oxygen at the proper pH, (acidity) and temperature. Upon completion of the treatment process, the slurry would be dewatered and the treated soil would be placed on site or disposed of off-site. Dependent upon the residence time required for the degradation process, the slurry-phase treatment system may be operated in batch or semi-continuous mode.

Bioremediation via land treatment involves placing contaminated soils in a lined treatment bed in a series of lifts (several inches thick). Between each lift, supplements such as manure and other nutrients would be mixed with the soils to enhance the biological degradation of the soil contaminants. The land treatment process would also include periodic cultivation of the soils to stimulate the biological degradation process.

Contained solid-phase biological treatment refers to a variety of treatment processes whereby excavated soils are mixed with nutrients and arranged in piles or placed in a treatment tank. The temperature and pH of the soils can be controlled throughout the treatment process. In addition, organic emissions from the piles or treatment tank may also be captured and treated.

Soil Vapor Extraction

Soil Vapor Extraction (SVE) is a treatment technology whereby air is withdrawn from impacted soils through a series of vapor extraction wells which have been installed and screened in contaminated soils. The air that is withdrawn through the extraction wells via vacuum pumps or blowers is replaced by ambient air. The resulting movement of air through the soil column serves to volatilize the volatile organic contaminants in the soils and facilitate removal of the contaminants. The contaminants that are removed via the extraction well air stream may require collection/treatment prior to discharge to the atmosphere. Carbon adsorption, thermal destruction, and condensation are some of the more common treatment technologies which may be employed to remove the organic contaminants from the air stream prior to discharge to the atmosphere. In many cases, the SVE treatment system may include a vapor-liquid separator to remove the moisture from the exit gas, thereby protecting the system blowers and increasing the efficiency of the vapor treatment process.

Pilot testing of this treatment technology at the Granville Solvents site indicated that the low-permeability of the clay-rich site soils prevented effective SVE treatment. Therefore, alteration of the site conditions would be necessary to facilitate effective treatment via SVE. Horizontal drilling and pneumatic fracturing are among the technologies currently available which may increase the permeability of the site soils and

facilitate effective treatment of the site soils via SVE. Additional study and evaluation of these technologies is necessary to determine which technology would be most effective and appropriate for this application.

4.1.2 Innovative Remedies

Enhanced Volatilization

Enhanced volatilization is a treatment process whereby excavated soils are processed using mechanical equipment (shredders, a hammermill, and pugmill) to facilitate the release of volatile organic contaminants from the soil. Dependent upon the concentration of contaminants in the treatment system air stream and the applicable regulatory requirements, the air stream may require additional treatment via carbon adsorption, thermal destruction, or condensation to reduce the concentration of organic constituents prior to discharge.

Low-Temperature Thermal Desorption

Low-Temperature Thermal Desorption (LTTD) is a technology which may be used to remove volatile organic contaminants from soil. The LTTD process employs aeration and heat to volatilize and drive off organic compounds from contaminated soil. LTTD systems heat contaminated soils to temperatures between 200 F and 1,000 F, driving off water and volatile contaminants in the soil matrix. As with the enhanced volatilization treatment process, the concentration of organic contaminants in the off-gas and regulatory requirements may dictate a need for off-gas treatment via carbon adsorption, thermal destruction, or condensation.

In-Situ Mixing/Steam Stripping

In-situ mixing/steam stripping is a treatment technology designed to volatilize and subsequently capture and treat volatile organic contaminants in soil. The treatment unit consists of two major elements, a process tower and an off-gas treatment system. The process tower's major components include two hollow augers to drill into and mix the soil, cutter bits to inject steam and hot air into the soil, and a treatment shroud which covers the ground surface above the augers to collect the volatilized soil vapors and direct the vapors into the off-gas treatment system. The gas treatment system's major components include a scrubber to remove entrained particulates, a cyclone separator to remove entrained water

droplets, a cooling system which condenses water vapor and volatile organic compounds in the gas stream, a distillation unit which serves to separate water and organic compounds in the condensed liquid stream, a carbon adsorption system that removes residual organic contaminants in the gas stream, and a compressor that serves to increase the temperature and the pressure of the treated gas stream prior to reinjection into the soil. The *in-situ* mixing/steam stripping process has been successfully demonstrated to remove volatile organic compounds from low-permeability (clay rich) soils at several contaminated sites throughout the U.S.

Soil Flushing

Soil flushing is an *in-situ* treatment process designed to mobilize soil contaminants for the purpose of recovery and treatment. Soil flushing uses water, enhanced water, or gaseous mixtures to accelerate subsurface contaminant transport mechanisms. Soil flushing is generally most effective in homogeneous, permeable soils (e.g., sands or silty sands with greater than 10^{-4} cm/sec permeability). This technology has several associated limitations including: the generation of large quantities of elutriate which will require treatment; general ineffectiveness at sites where the soil contaminants are tightly bound to the soil (as is the case at the Granville Solvents Site); the potential for problematic interactions of surfactants in the flushing solution with the biological, physical, and chemical properties of the unsaturated zone; and uncertainties in the overall reliability of the soil flushing technology due to limited experience in the technology's at contaminated sites to date.

5.0 SOIL DATA COLLECTION PLAN TO SUPPORT ENGINEERING DESIGN ACTIVITIES

This section of the DTM provides a summary of the plans to collect and analyze soil samples from the GSS. The data resulting from the sample collection and analysis activities will be used to perform a further engineering evaluation and cost analysis of candidate treatment technologies for the impacted GSS soils. Both physical and chemical soil data will be obtained during the sampling investigation. The plan to obtain the physical and chemical soil data from the GSS is presented below. The Quality Assurance Project Plan (Metcalf & Eddy, 1995) for the GSS should be referenced for additional details and procedures concerning the soil data collection plan.

5.1 BASIS FOR SAMPLING PLAN DEVELOPMENT

This DTM sampling plan presents the proposed approach to collect additional GSS soil data. The objective of this sampling plan is to obtain physical and chemical soil data which will support the evaluation of several candidate treatment technologies and ultimately assist in the preliminary design and implementation of a soil treatment remedy. As presented in Section 3.0 of this DTM, the candidate treatment technologies currently under consideration for the GSS soil are limited to the following:

- Excavation and Bioremediation
- *In-Situ* Soil Vapor Extraction¹
- Excavation and Low Temperature Thermal Desorption
- Excavation and Enhanced Volatilization
- *In-Situ* Mixing/Steam Stripping
- *In-Situ* Soil Flushing

The following is a summary of the process used to develop the sampling plan for the GSS soils:

1. The physical and chemical data requirements for the evaluation of candidate treatment technologies were identified.
2. Chemical data requirements for the estimation of the vertical and horizontal extent of site soil contamination were identified.

¹ Based on the results of pilot SVE tests previously performed at the GSS, increasing the air permeability of the site soils via pneumatic fracturing or a similar technology will be necessary in some areas of the site to facilitate effective soil treatment via SVE.

The following DTM subsections provide a description of the proposed GSS soil sampling plan and supporting information used to develop the plan.

5.2 PHYSICAL SOIL DATA COLLECTION PLAN

With respect to the physical soil data needs for these treatment technologies, treatment vendors specializing in these technologies have been contacted to develop a list of data needs for each technology. Table 5-1 provides a summary of these data needs. Based on these data needs, and the understanding that soil data which may assist in the evaluation of contaminant transport may be needed in the future, the following tests will be performed on the soil samples which are collected for physical analyses:

- Particle Size Analysis
- Atterberg Limits
- USCS Classification
- Moisture Content
- Specific Gravity
- Cation Exchange Capacity
- Bulk Density
- Eh
- Total Organic Carbon
- Soil pH
- Flexible Wall Permeability Test

The soil samples for physical analyses will be collected from six different site locations at depth intervals of 2-4 feet, 6-8 feet, 12-14 feet, and 18-20 feet below ground surface.. Based on M&E's current understanding of the site characteristics and stratigraphy, the GSS was broken into three separate areas to select the locations for the collection of physical soil samples. These areas include the Flood Plain Area, the Glacial Terrace, and the Fill Area. Soil samples from two different locations within each of these areas will be collected and analyzed for the physical parameters noted above. This sampling plan is expected to provide physical soil data which is representative of the soils in the three different site areas. Figure 5-1 should be referenced for the proposed sample locations for physical analysis.

5.3 CHEMICAL SOIL DATA COLLECTION PLAN

Chemical soil data will be compared with PRGs concentration levels (see Section 3) to determine which of the site soils exceed the PRGs levels . A plan for the collection of chemical soil data from the GSS has been developed to support a fairly concise delineation of these soils areas . A reasonably accurate

delineation of these soil areas is necessary to provide the information required to assist in the evaluation, selection, development, and design of a treatment remedy for the impacted site soils.

A common set of conditions and rationale was used in developing the chemical sampling and analysis plan for the Granville Solvents Site. These conditions and rationale are summarized below:

- The sampling plan was developed with the understanding that the contaminants in the site soils are the result of leaks from underground storage tanks and surface spills in the warehouse area. Based upon this understanding, the contaminant concentrations in the site soils are expected to be highest near these source areas and become progressively lower as the distance from these source areas increases. The sampling plan has not been designed to identify isolated areas of contamination or contaminant "hot spots".
- Based on the available site data, the soils by the warehouse and former tank farm will be considered to be impacted. Consequently, only limited sampling is proposed in this area. Figure 5-1 provides an illustration of this area. The impacted soil area, designated as Area A for the purposes of this discussion, covers approximately 7,200 square feet. Available site data indicate that the Area A soils are generally impacted down to the water table (approximately 20 feet deep). Based on an impacted soil depth of 20 feet, the total volume of impacted soils within Area A is approximately 5,300 cubic yards. The sampling investigation will include the collection and analysis of 12 samples from three boring locations (4 samples per boring collected at the 2- to 4-, 6- to 8-, 12- to 14-, and 18- to 20-foot intervals) in this area. Two of these boring locations are located outside the warehouse and one boring is located inside the warehouse. The analyses proposed for all soil samples are described below. The resulting data from these borings will assist in establishing "worst case" contaminant concentration conditions for the site soils and assist in the evaluation of soil treatment technologies. It should be noted that designating Area A as an area of impacted soils is not intended to indicate that this is the only site area which contains impacted soils. As noted above, the chemical data obtained from this investigation will be used to assist in determining the extent of impacted site soils.
- The sampling investigation will be performed in two phases. The first phase of the investigation will entail the collection and analysis of soil samples from 27 boring

locations (24 boring locations outside Area A and 3 boring locations within Area A) from a 50 x 50 foot sampling grid (see Figure 5-1 for sampling locations). Upon receipt of the analytical results from the first phase of the investigation, a sampling plan for the second phase will be developed to assist in the refinement of the site soil areas where chemicals that exceed the PRG concentration values are identified.

- A direct comparison of the proposed PRGs concentrations with chemical concentrations in the soil will be made to define the soil locations or areas which exceed the PRGs values.
- One soil boring will be completed within each grid block at the boring locations noted in Figure 5-1. Four samples will be collected from each boring at the 2- to 4-, 6- to 8-, 12- to 14-, and 18- to 20-foot intervals. All samples will be analyzed for TCL VOCs (SW-8260). In addition, samples collected from the three boring locations within Area A and five of the eleven grid block boring locations immediately adjacent to Area A (see Figure 5-1) will be analyzed for TCL semi-volatile organic compounds (SW-8270) and the eight RCRA metals (SW-6010/7000s). These areas have been chosen for semivolatile organic compounds and metals analysis because the area designated as impacted and the surrounding area is considered to be the location where metals and semivolatile organic compounds, if present, are most likely to be detected.
- Background samples will be collected from seven boring locations near the Granville Solvents site. Figure 5-2 should be referenced for the proposed boring locations for the background samples. Samples will be collected from each boring location at intervals of 2-4, 6-8, 12-14, and 18-20 feet below ground surface and analyzed for the 8 RCRA metals.
- All soil samples will be screened in the field for the presence of non-aqueous phase liquids (NAPLs). In addition, the three borings located in Area A will be continuously screened for the presence of NAPLs. The NAPLs screening method will incorporate the use of fluorescence, centrifugation, and the addition of hydrophobic dye. A detailed description of the NAPLs screening method is included in the Quality Assurance Project Plan (QAPP) document that has been prepared for the Granville Solvents site.

- In order to identify NAPLs that may be present below the water table, two samples will be collected from below the water and screened for the presence of NAPLs. As noted above, the NAPLs screening method will incorporate the use of fluorescence, centrifugation, and hydrophobic dye. (The QAPP document should be referenced for procedural details.) The samples will be collected from depths of 3-5 and 8-10 feet below the encountered water table at all 27 of the boring locations proposed for the first phase of the sampling investigation.
- In estimating the amount of time required to complete the first phase of the sampling investigation, it has been planned that a total of four borings would be completed in one day (16 VOC samples/day plus 3 additional samples for QA/QC purposes, i.e., field duplicates, field blanks, and trip blanks).

5.4 REFERENCES

Metcalf & Eddy, Inc., 1995. Quality Assurance Project Plan for the Granville Solvents Site. August 1995.

TABLES

Table 2-1
Concentrations of Volatile Organic Compounds in the
Soil Cuttings From Wells 4D, 5, 7, and 7D
(Concentrations Reported in ug/kg)

Granville Solvents Site
Granville, Ohio

Compound	Well/Boring I.D.			
	MW-4D	MW-5	MW-7	MW-7D
1,2 - Dichloroethane	BDL	BDL	0.0076 (a)	BDL
Styrene	BDL	BDL	0.00727 (a)	BDL
Tetrachloroethene	161.59	BDL	BDL	BDL
1,1,2 - Trichloroethane	40.92	BDL	BDL	BDL
Trichloroethene	155.22	BDL	BDL	BDL
Total Xylenes	43.3	BDL	BDL	BDL

BDL = Below Detection Limit

Note: Samples were collected and analyzed in June 1991 in a field laboratory.

OEPA has requested that these data be used for reconnaissance purposes only.

Source: Granville Solvents Interim Action Report Dated August 26, 1992, prepared by Compliance Solutions, Inc.

- (a) These concentrations are presented here as reported in the above-referenced source document. However, these reported concentrations are considered suspect based upon achievable analytical detection limits.

Table 2-2
Metal, Cyanide, and Organic Constituents Detected in the Soil Sample
Collected From the Northeast Corner of the Warehouse Building
(Sample collected from a depth of 18 inches below ground surface)

Granville Solvents Site
Granville, Ohio

Constituent	Concentration (ug/kg)
Aluminum	100,000
Arsenic	2,325
Barium	60,000
Beryllium	500
Cadmium	400
Chromium	7,600
Cobalt	9,300
Copper	16,000
Iron	290,000
Lead	10,000
Manganese	335,000
Mercury	5,910
Nickel	26,000
Thallium	1,000
Vanadium	31,000
Zinc	34,000
Cyanide	30
Benzene	3,800
Cis - 1,2 - Dichloroethene	3,630
Ethylbenzene	87,700
Methylene chloride	10,800
Tetrachlorethene	204,000
Toluene	160,600
1,1,1 - Trichloroethane	242,900
Trichloroethene	202,300
Total Xylenes	297,300
Napthalene	6,060
Alpha - BHC	623
Beta - BHC	436,700

Note: Samples were collected and analyzed in October 1991.

Source: Granville Solvents Interim Action Report Dated August 26, 1992, prepared by Compliance Solutions, Inc.

Table 2-3
Organic Constituents Detected in the
Soil Cuttings From Well P1
(Concentrations Reported in ug/kg)

Granville Solvents Site
Granville, Ohio

Constituent	Sample Depth		
	3 feet	20 feet	26 feet
1,1 – Dichloroethane	BDL	BDL	221
Cis – 1,2 – Dichloroethene	117	406	187.6
Ethylbenzene	552	BDL	BDL
Styrene	516	BDL	BDL
Tetrachloroethene	177.3	226.9	2,254
Toluene	231	BDL	BDL
1,1,1 – Trichloroethane	393	1,963	1,368
Trichloroethene	1,840	1,132	2,742
Total Xylenes	88	BDL	BDL

BDL = Below Detection Limit

Note: Samples were collected and analyzed in October 1991.

Source: Granville Solvents Interim Action Report Dated August 26, 1992, prepared by

Table 3-1 Summary of Chemicals Detected in Environmental Media

Chemicals Stated in the Administrative Consent Order	
Volatile Organic Chemicals (VOCs)	
Chemicals Detected in the Ground Water at the Granville Solvents Site May 1994	
	1,1,1-trichloroethane 1,1-dichloroethane acetone bromodichloromethane bromoform chloroform cis-1,2-dichloroethene dibromochloromethane ethylbenzene m- & p-xylene o-xylene tetrachloroethene toluene trans-1,2-dichloroethene trichloroethene
Chemicals Detected in Hydropunch Samples at the Granville Solvents Site April and May 1994	
	1,1,1-trichloroethane 1,1-dichloroethene 1,1-dichloroethane 2-butanone 2-hexanone acetone benzene carbon disulfide chloromethane cis-1,2-dichloroethene tetrachloroethene toluene trans-1,2-dichloroethene trichloroethene vinyl chloride
Chemicals Detected in the Soils at the Granville Solvents Site May 1994	
	1,1,1-trichloroethane 1,1-dichloroethene 2-butanone acetone tetrachloroethene trichloroethene

Table 3-2 Summary of Ohio and U.S. EPA Maximum Contaminant Levels (MCLs) for Drinking Water for the Granville Solvents Site

ANALYTE	U.S. EPA MCL (ug/l) (a)	Ohio EPA MCL (ug/l) (b)
1,1,1-trichloroethane	200	200
1,1-dichloroethene	7	7
1,1-dichloroethane	—	—
2-butanone	—	—
2-hexanone	—	—
acetone	—	—
benzene	5	5
bromodichloromethane	100*	100*
bromoform	100*	100*
carbon disulfide	—	—
chloroform	100*	100*
chloromethane	—	—
cis-1,2-dichloroethene	70	70
dibromochloromethane	100*	100*
ethylbenzene	700	700
m- & p-xylene	10000	10000
o-xylene	10000	10000
tetrachloroethene	5	5
toluene	1000	1000
trans-1,2-dichloroethene	100	100
trichloroethene	5	5
vinyl chloride	2	2
Bis(2-ethylhexyl)phthalate	6	6

Sources:

(a) U.S. EPA. 1994. Drinking Water Regulations and Health Advisories. Office of Water. November 1994.

(b) Ohio EPA. 1994-2. Primary Drinking Water Regulations. Ohio Administrative Code (OAC) 3745-81-11 and OAC 3745-81-12. Effective September 13, 1993.

* The MCL for total trihalomethanes includes the four chemicals designated above.

Table 3-3 Summary of U.S. EPA Region III and Region IX Risk-Based Groundwater PRGs

	TAPWATER	
	Region III PRGs (ug/L) (a)	Region IX PRGs (ug/L) (b)
1,1,1-trichloroethane	1300	1300
1,1-dichloroethene	0.044	0.046
1,1-dichloroethane	810	810
2-butanone	1900	1900
2-hexanone	NL	NL
acetone	3700	610
benzene	0.36	0.39
bromodichloromethane	0.17	0.18
bromoform	2	9
carbon disulfide	21	21
chloroform	0.15	0.16
chloromethane	1.4	1.5
cis-1,2-dichloroethene	61	61
dibromochloromethane	0.1	1
ethylbenzene	1300	1300
m- & p-xylene	520	1400
o-xylene	1400	1400
tetrachloroethene	1.1	1.1
toluene	750	720
trans-1,2-dichloroethene	120	120
trichloroethene	1.6	1.6
vinyl chloride	0.019	0.02
Bis(2-ethylhexyl)phthalate	4.8	4.8

NL -- Not Listed

PRG -- Preliminary Remediation Goal

Sources:

(a) U.S. EPA, Region III. 1995. Risk-Based Concentration Table, January-June 1995.
March 7, 1995.

(b) U.S. EPA, Region IX. 1995 EPA Region IX Preliminary Remediation Goals (dated 02/01/95).

Table 3-4 Summary of U.S. EPA Region III and Region IX Risk-Based PRGs for Soil for Direct Contact

	RESIDENTIAL SOIL		OCCUPATIONAL SOIL		Residential EPA SSLs (ug/kg) (c)
	Region III PRGs (ug/kg) (a)	Region IX PRGs (ug/kg) (b)	Region III PRGs (ug/kg) (a)	Region IX PRGs (ug/kg) (b)	
1,1,1-trichloroethane	7000000	3200000	180000000	3000000	980000
1,1-dichloroethene	1100	38	9500	82	40
1,1-dichloroethane	7800000	840000	200000000	3900000	980000
2-butanone	47000000	8700000	1000000000	34000000	NL
2-hexanone	NL	NL	NL	NL	NL
acetone	7800000	2000000	200000000	8400000	7800000
benzene	22000	1400	200000	3200	500
bromodichloromethane	10000	1400	92000	3400	5000
bromoform	81000	56000	720000	240000	46000
carbon disulfide	7800000	16000	200000000	52000	11000
chloroform	100000	530	940000	1100	200
chloromethane	49000	2000	440000	4300	7000
cis-1,2-dichloroethene	780000	59000	20000000	200000	780000
dibromochloromethane	7600	5300	68000	23000	NL
ethylbenzene	7800000	2900000	200000000	3100000	260000
m- & p-xylene	160000000	980000	1000000000	980000	320000*
o-xylene	160000000	980000	1000000000	980000	320000*
tetrachloroethene	12000	7000	110000	25000	11000
toluene	16000000	1900000	410000000	2700000	520000
trans-1,2-dichloroethene	1600000	170000	41000000	600000	1600000
trichloroethene	58000	7100	520000	17000	3000
vinyl chloride	340	5	3000	11	2

ND - Not Determined

NL - Not Listed

SSL - Soil Screening Levels

* Indicates that this value is for mixed xylenes

Sources:

(a) U.S. EPA, Region III. 1995. Risk-Based Concentration Table, January-June 1995. March 7, 1995.

(b) U.S. EPA, Region IX. 1995 EPA Region IX Preliminary Remediation Goals (dated 02/01/95).

(c) U.S. EPA 1994. Comparison of EPA's First 30 Draft Generic Soil Screening Levels with States' Soil Levels. December 1994. The more conservative of the ingestion and inhalation value was chosen here.

Note:

The risk-based PRGs are purely derived using risk assumptions. Physical characteristics of the chemicals and the adsorptive limits of the soil matrix have not been incorporated into the PRG calculations. A value of 1E-09 represents a 100% concentration of the substance of interest; physically, there can be no meaning, other than, 100% concentration, to higher values.

Table 3-5 Summary of Risk-Based Soil PRGs for Direct Contact and Protective Soil Levels Based on Soil to Groundwater Migration

CHEMICAL	RISK-BASED PRGs (a)						SOIL TO GROUNDWATER MIGRATION (b)			
	ON-SITE RECEPTOR		OFF-SITE RECEPTOR				U.S. EPA	U.S. EPA Region IX	U.S. EPA Region III	U.S. EPA
	EXCAVATION	ENVIRONMENTAL	RESIDENT		BIKER/WALKER		MCL-Based	PRG-Based	Soil Screening Levels	Soil Screening Levels
	WORKER	SAMPLER	ADULT	CHILD	ADULT	CHILD	DAF = 10	DAF = 10	DAF = 10	DAF = 10
	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	CONCENTRATION IN SOIL (ug/kg)			
1,1,1-Trichloroethane	4.63E+08	9.26E+08	1.71E+07	3.66E+06	2.14E+09	4.58E+08	2825.08	18362.99	900	900
1,1-Dichloroethene	3.43E+03	4.42E+03	3.37E+01	3.61E+01	4.21E+03	4.51E+03	45.20	0.30	30	30
1,1-Dichloroethane	6.18E+08	3.09E+09*	1.14E+07	2.43E+06	1.42E+09	3.04E+08	2113.97	2446.16	11000	11000
2-Butanone	1.86E+08	9.26E+08	1.60E+07	3.42E+06	2.00E+09	4.28E+08	516.71**	233.75	NL	NL
2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND	NL	NL
Acetone	9.42E+08	2.13E+11*	3.08E+07	6.60E+06	3.85E+09	8.25E+08	26.01**	22.66	8000	8000
Benzene	1.41E+05	1.82E+05	2.91E+03	3.11E+03	3.63E+05	3.89E+05	39.72	3.10	20	20
Bromodichloromethane	4.81E+06	9.26E+06	1.14E+02	1.22E+02	1.42E+04	1.52E+04	616.60	1.11	300	300
Bromoform	1.03E+06	1.34E+06	9.74E+04	1.04E+05	1.22E+07	1.30E+07	1819.70	154.67	500	500
Carbon disulfide	5.84E+06	9.08E+06	1.07E+05	2.29E+04	1.33E+07	2.86E+06	20658.46**	619.75	14000	14000
Chloroform	5.11E+04	6.57E+04	9.07E+02	9.72E+02	1.13E+05	1.21E+05	441.57	0.71	300	300
Chloromethane	6.39E+05	8.30E+05	4.82E+03	5.16E+03	6.02E+05	6.45E+05	110.77**	3.77	6.6	10
cis-1,2-Dichloroethene	9.42E+07	2.13E+10*	1.29E+06	2.76E+05	1.61E+08	3.45E+07	556.03	484.54	200	200
Dibromochloromethane	3.55E+06	7.10E+06	2.80E+03	3.00E+03	3.50E+05	3.75E+05	831.76	8.32	200	200
Ethylbenzene	5.72E+08	9.00E+08	1.66E+07	3.55E+06	2.07E+09	4.44E+08	12737.91	23656.11	5000	5000
m- & p Xylenes	6.03E+08	9.37E+08	2.38E+07	5.11E+06	2.98E+09	6.38E+08	371535.23	52014.93	230000	74000 (total)
o-Xylenes	6.03E+08	9.37E+08	2.00E+07	4.29E+06	2.50E+09	5.36E+08	263026.80	36823.75	150000	74000 (total)
Tetrachloroethene	1.52E+06	2.16E+06	3.71E+04	3.98E+04	4.64E+06	4.97E+06	135.82	29.88	40	40
Toluene	7.80E+08	9.37E+08	1.42E+07	3.05E+06	1.78E+09	3.82E+08	16218.10	11677.03	5000	5000
trans-1,2-Dichloroethene	2.92E+08	4.26E+10*	5.38E+05	1.15E+05	6.73E+07	1.44E+07	588.84	706.61	300	300
Trichloroethene	6.73E+05	8.73E+05	1.25E+04	1.34E+04	1.57E+06	1.68E+06	47.75	15.28	20	20
Vinyl chloride	1.27E+04	1.68E+04	2.47E+00	2.65E+00	3.09E+02	3.31E+02	0.49	0.005	10	10

DAF - Dilution Attenuation Factor

ND - Not determined since toxicity values not available

NL - Not Listed

PRG - Preliminary Remediation Goal

(a) The risk-based PRGs are purely derived using risk assumptions. Physical characteristics of the chemicals and the adsorptive limits of the soil matrix have not been incorporated into the PRG calculations.

Asterisks indicate theoretical results derived from mathematical manipulations but which have no physical meaning.

A value of 1E-09 represents a 100% concentration of the substance of interest; physically, there can be no meaning, other than, 100% concentration, to higher values.

(b) Sources:

U.S. EPA. 1994. Drinking Water Regulations and Health Advisories. Office of Water. November 1994.

U.S. EPA, Region III. 1995. Risk-Based Concentration Table, January-June 1995.

U.S. EPA, Region IX. 1995 EPA Region IX Preliminary Remediation Goals (dated 02/01/95).

U.S. EPA 1994. Comparison of EPA's First 30 Draft Generic Soil Screening Levels with States' Soil Levels. December 1994. The more conservative of the ingestion and inhalation value was chosen here.

** These values were derived using a non-enforceable M&E value calculated specifically for this chemical based on the methodology for calculation of a Maximum Contaminant Level Goal (MCLG) provided in the National Primary Drinking Water Regulations (Federal Register 56(20), January 30, 1991; 40 CFR Parts 141, 142, 143).

NOTE: Shading indicates the soil PRGs that appear in Table 3-6

**TABLE 3-6
SUMMARY OF PRELIMINARY REMEDIATION GOALS**

Chemical Name	SOIL PRGs ($\mu\text{g/kg}$) ⁽¹⁾	GROUNDWATER PRGs ($\mu\text{g/L}$) ⁽²⁾
1,1 Dichloroethene	30	7
1,1 Dichloroethane	11,000	810 ^b
2-Butanone	517 ^a	1,900 ^b
2-Hexanone	ND	ND
Acetone	8,000	610
Benzene	20	5
Bromodichloromethane	300	100
Bromoform	500	100
Carbon Disulfide	14,000	21 ^b
Chloroform	300	100
Chloromethane	7	1.4 ^b
cis 1,2 Dichloroethene	200	70
Dibromochloromethane	200	100
Ethylbenzene	5,000	700
Xylenes	74,000	10,000
Tetrachloroethene	40	5
Toluene	5,000	1,000
trans 1,2 Dichloroethene	300	100
Trichloroethene	20	5
Vinyl Chloride	10	2

^a U.S. EPA has not derived a soil screening level for 2-butanone. Therefore, a predictive fate and transport model was used to estimate the PRG to protect groundwater. A dilution and attenuation factor of 10 is included in the model.

^b MCLs have not been developed for these compounds. Therefore, the value represents the lowest risk-based PRG for drinking water.

ND Not determined because toxicity values have not been derived for 2-hexane.

1) These summarized values are protective against chemical migration from soil to groundwater. The soil PRG is the lower value of the U.S. EPA Region III and Region IX soil screening level. If a value is not listed for either of the soil screening levels, the U.S. EPA MCL-based level is used (Table 3-5 of the text).

2) The groundwater PRG is the U.S. EPA maximum contaminant level (MCL). If an MCL is not available, then the PRG is the lower value of the U.S. EPA Region III and Region IX risk-based groundwater values (Tables 3-2 and 3-3 of the text).

TABLE 4-1
Evaluation of Established Soil Remediation Technologies
for Impacted Soils at the Granville Solvents Site
Granville, Ohio

General Response Actions	Potential Remedial Action Technologies/Description	Retained For Further Analysis?	Screening Comments	Advantages	Disadvantages
Containment	Capping – A low – permeability barrier placed over an area containing buried waste or contaminated soil. Limits surface water infiltration and subsequent migration of soil contaminants. Also reduces exposure to surface soil contaminants.	Yes	A proven technology to prevent migration of and exposure to soil contaminants.	* Low cost.	* Contaminants remain on–site; potential for future liabilities.
Removal/Disposal/Treatment	<u>Removal:</u>				
	Excavation – Use of heavy equipment and machinery to remove contaminated soils from the landfill sites.	Yes	Excavation of impacted soils followed by treatment and/or disposal is a potentially applicable remedial option.	* Contaminated soils are removed. * Treatment of excavated soils can be performed under more controlled conditions when compared with in–situ treatment remedies.	* Cost of excavation. * Potential for site workers to be exposed to soil contaminants during removal/loading of impacted soils.
	<u>Disposal:</u>				
	Off–Site Disposal at a Hazardous Waste Landfill – Disposal of treated or untreated soils at an off–site hazardous waste landfill facility.	Yes	Potentially applicable remedial action for the disposal of untreated contaminated soils at the Granville Solvents site.	* Impacted soils are permanently removed from the site.	* High cost * Future liability for disposal, particularly if soils are not treated prior to disposal. * Land disposal restrictions may apply.
	Off–Site Disposal at a Solid Waste Landfill – Disposal of treated soils at an off–site solid waste landfill.	Yes	Potentially applicable remedial action for the disposal of soils that have been excavated and treated on–site.	* Impacted soils are permanently removed from the site. * Less costly than hazardous waste landfill disposal.	* Future liability for disposal, particularly if soils are not treated prior to disposal. * Land disposal restrictions may apply.
	On–Site Placement – Placement of treated soils on–site as fill material.	Yes	If contaminants in the soils are effectively treated to reduce future human health risks, on–site placement of the treated soils may be considered as a disposal option.	* Low cost.	* Some potential for future liabilities.
	<u>Treatment:</u>				
	Incineration – High temperature thermal destruction of organic compounds.	No	Potentially applicable technology for treatment of organic contaminants in site soil. The public's general opposition to incineration would make this technology difficult to implement on–site. Off–site transportation and treatment costs are considered to be prohibitively high.	* Soil contaminants are permanently destroyed.	* Very high cost. * Approval of on–site treatment by nearby residents is considered unlikely.
	Soil Washing – An aqueous –based technology that, in general, uses mechanical processes to separate soil particles which contain contaminants. The contaminants can then be removed from the soil particles through solubilization in the wash water. The wash water may be augmented with a leaching agent, surfactant, pH adjustment, or chelating agent as appropriate.	No	This treatment technology is most effective when applied to soils and sediments containing large proportions of sand and gravel and is relatively ineffective when applied to soils having a high silt and clay content, as is the case the GSS soils.	* Moderate cost.	* Not technically feasible for soils with high silt and clay content.
	Bioremediation – A treatment process which provides for biological degradation of organic contaminants in soil with the aid of nutrients. Numerous treatment options (i.e., slurry–phase treatment, composting, landfarming) are included under this technology. Selection of the most appropriate treatment process is made based upon site–specific conditions and contaminants.	Yes	Technical feasibility of this technology may be limited by the high clay content of the site soils. Treatability tests should be performed to establish the anticipated effectiveness of this treatment technology.	* Low to moderate cost. * Treatment may be tailored to site – specific contaminants.	* Treatability studies are necessary to determine the effectiveness of this technology prior to implementation.
	In–Situ Bioremediation – Treatment process which provides for the biological degradation of organic contaminants in the site soils via the addition of the appropriate nutrients and/or microorganisms.	No	This technology is generally ineffective in clay–rich soils because the clay would inhibit the migration of treatment solutions, thereby limiting the technology's effectiveness.	* Soil treatment may be performed without excavation of the soil. * Low to moderate cost.	* Clay–rich soils would limit the effectiveness of this treatment technology.
	Vapor Extraction – In–situ volatilization of organic contaminants in soil through the application of a vacuum system to a centrally located extraction well or series of extraction wells in the zone of contamination. The collected gas is then treated prior to discharge.	Yes	Although on–site testing of this technology indicated that the clay–rich soil is too impervious to allow effective treatment of the site soils using vapor extraction, this technology may be appropriate when used in combination with a technology or process which increases the permeability of the site soils (e.g., hydraulic or pneumatic fracturing, horizontal drilling, etc.)	* Low cost. * Soil treatment may be performed without excavation of the soil.	* Additional study is necessary to determine if soil matrix can be altered to facilitate treatment via soil vapor extraction.
In–Situ Treatment					

TABLE 4-2
Evaluation of Innovative Soil Remediation Technologies
for Impacted Soils at the Granville Solvents Site
Granville, Ohio

General Response Action	Potential Remedial Action Technologies/Description	Retained For Further Analysis?	Screening Comments	Advantages	Disadvantages
Treatment	<u>Ex-Situ Treatment:</u>				
	Enhanced Volatilization – Use of hammermill/pugmill equipment to mix excavated soils. The mixing action serves to volatilize the volatile organic contaminants in the soil. The volatilized contaminants can then be captured or treated, if necessary, using an appropriate control technology (e.g., carbon adsorption or oxidation units).	Yes	Potentially applicable technology for the treatment of volatile organic contaminants in the site soils. The clay soils may contain strongly adsorbed organic constituents which respond unfavorably to this treatment technology. Treatability tests should be performed to evaluate the effectiveness of this technology and to assist in estimating the cost to implement this technology.	<ul style="list-style-type: none"> • Low to moderate cost. 	<ul style="list-style-type: none"> • Treatability testing is necessary to establish the anticipated effectiveness of this technology. • The high clay content of the site soils may result in poor processing performance.
	Low Temperature Thermal Desorption – Low temperature heat and aeration are used to thermally strip organic compounds from contaminated soil. As with enhanced volatilization, the volatilized organic compounds may be captured or treated, if necessary, using an appropriate control technology.	Yes	Potentially applicable technology for the treatment of volatile organic contaminants in the site soils. The clay soils may contain strongly adsorbed organic constituents which respond unfavorably to this treatment technology. Treatability tests should be performed to evaluate the effectiveness of this technology and to assist in estimating the cost to implement this technology.	<ul style="list-style-type: none"> • Contingent upon treatability test results, cost may be low to moderate. 	<ul style="list-style-type: none"> • The moisture content of the site soils may make this treatment technology cost-prohibitive. • Treatability testing is necessary to establish the anticipated effectiveness of this technology. • The high clay content of the site soils may result in poor processing performance.
	<u>In-Situ Treatment:</u>				
	In-Situ Radio Frequency (RF) Heating – Electrodes inserted into contaminated soil through drilled boreholes to heat soil volumetrically and uniformly to temperatures between 150 C and 300 C. Heating serves to vaporize volatile and semi-volatile organic compounds which are collected with a vapor extraction and treatment system.	No	This innovative technology is not well-proven or widely available and is not cost-effective at sites which have relatively small to moderate volumes of soil contamination.	<ul style="list-style-type: none"> • Soil treatment may be performed without excavation of the soil. 	<ul style="list-style-type: none"> • Very high cost. • Technology not widely available.
	In-Situ Vitrification – Use of high-intensity electric currents transferred within a square array of electrodes which have been inserted into contaminated soils. Organic contaminants are volatilized and inorganic contaminants are solidified into a stabilized vitreous block. Evolved gases containing organic contaminants are trapped under an off-gas cover for treatment.	No	This innovative technology is not well-proven or widely available and is not cost-effective at sites which have relatively small to moderate volumes of soil contamination.	<ul style="list-style-type: none"> • Soil treatment may be performed without excavation of the soil. • Contingent upon treatability test results, cost may be low to moderate. 	<ul style="list-style-type: none"> • Very high cost. • Technology not widely available.
	In-Situ Mixing/Steam Stripping – Use of a mobile drilling unit to mix and inject steam into contaminated soil. The injected steam transforms the soil-bound organic contaminants into contaminant vapors. The organic contaminant vapors migrate to the ground surface and are captured within a metal shroud under slight vacuum and treated via condensation and carbon polishing to remove the organic contaminants.	Yes	This innovative technology is potentially applicable for the treatment of the organic contaminants in the site soils.	<ul style="list-style-type: none"> • Soil treatment may be performed without excavation of the soil. • Contingent upon treatability test results, cost may be moderate. 	<ul style="list-style-type: none"> • Pockets of contaminated perched groundwater which may be present in the soils above the water table may be driven into the underlying aquifer.
	Soil Flushing – The use of water or enhanced water solutions to facilitate the transport of soil contaminants into the groundwater. The contaminants which migrate into the groundwater would then be collected and treated with a conventional groundwater pump and treat system.	Yes	This technology is generally ineffective in clay-rich soils because the clay would inhibit the migration of soil washing solutions, thereby limiting the technology's effectiveness. However, alteration of the site soils via pneumatic fracturing, horizontal drilling, or similar technologies designed to improve the soil permeability may result in effective soil flushing treatment.	<ul style="list-style-type: none"> • Soil treatment may be performed without excavation of the soil. 	<ul style="list-style-type: none"> • Clay-rich soils are expected to limit the effectiveness of this treatment technology. • Promoting the transport of soil contaminants into the groundwater table may be considered imprudent based on regulatory considerations, the potential need for upgrading of the existing groundwater treatment system, and the close proximity of municipal water supply wells to the site.

TABLE 5-1
Granville Solvents Site
Data Needs Summary

<u>Technology</u>	<u>Data Needs</u>
Biological Treatment	Bacterial Enumeration* Biodegradation Confirmation* Isolation of Specific Bacteria Colonies* (degrader identification) Range of Conditions Study* Hydrogeology Soil pH
Enhanced Volatilization	Moisture Content Grain Size Analysis/Particle Size Distrib. Bulk Soil Density
Hydraulic Fracturing/ SVE	Atterburg Limits Plastic Limits Liquid Limits Moisture Content
Low Temperature Thermal Desorption	Moisture Content Grain Size Analysis/Particle Size Distrib. Bulk Soil Density
<i>In-Situ</i> Mixing/Steam Stripping	Presence of Fractures or Perched Groundwater Total Organic Carbon Content
Soil Flushing	Grain Size Analysis/Particle Size Distrib. Bulk Soil Density

-
- * Based on the high clay content of the site soils and the presence of a variety of chlorinated and non-chlorinated organic species which would complicate the biological treatment process, testing for biological parameters is not proposed at this time. However, it is recognized that additional site data may indicate that biological treatment warrants further consideration and that biological treatment of chlorinated organic compounds is an issue of continuing research that may ultimately result in future scientific developments and breakthroughs. Therefore, testing for biological parameters may be performed at the Granville Solvents Site in the future.

FIGURES

nonresponsive

NOTES:

GSS-EW1 PUMPING AT 200 GPM
GSS-EW2 PUMPING AT 100 GPM
VILLAGE WELL PW-2 PUMPING AT ABOUT 750 GPM

EXPLANATION

- CONCRETE MONUMENT SET
- MONITOR WELLS
- ▲ PIEZOMETER
- EXTRACTION WELLS
- VILLAGE PRODUCTION WELLS
- OBSERVATION WELL
- HYDROPUNCH LOCATION
- BUILDING

CONTOUR INTERVAL = 0.2 FEET

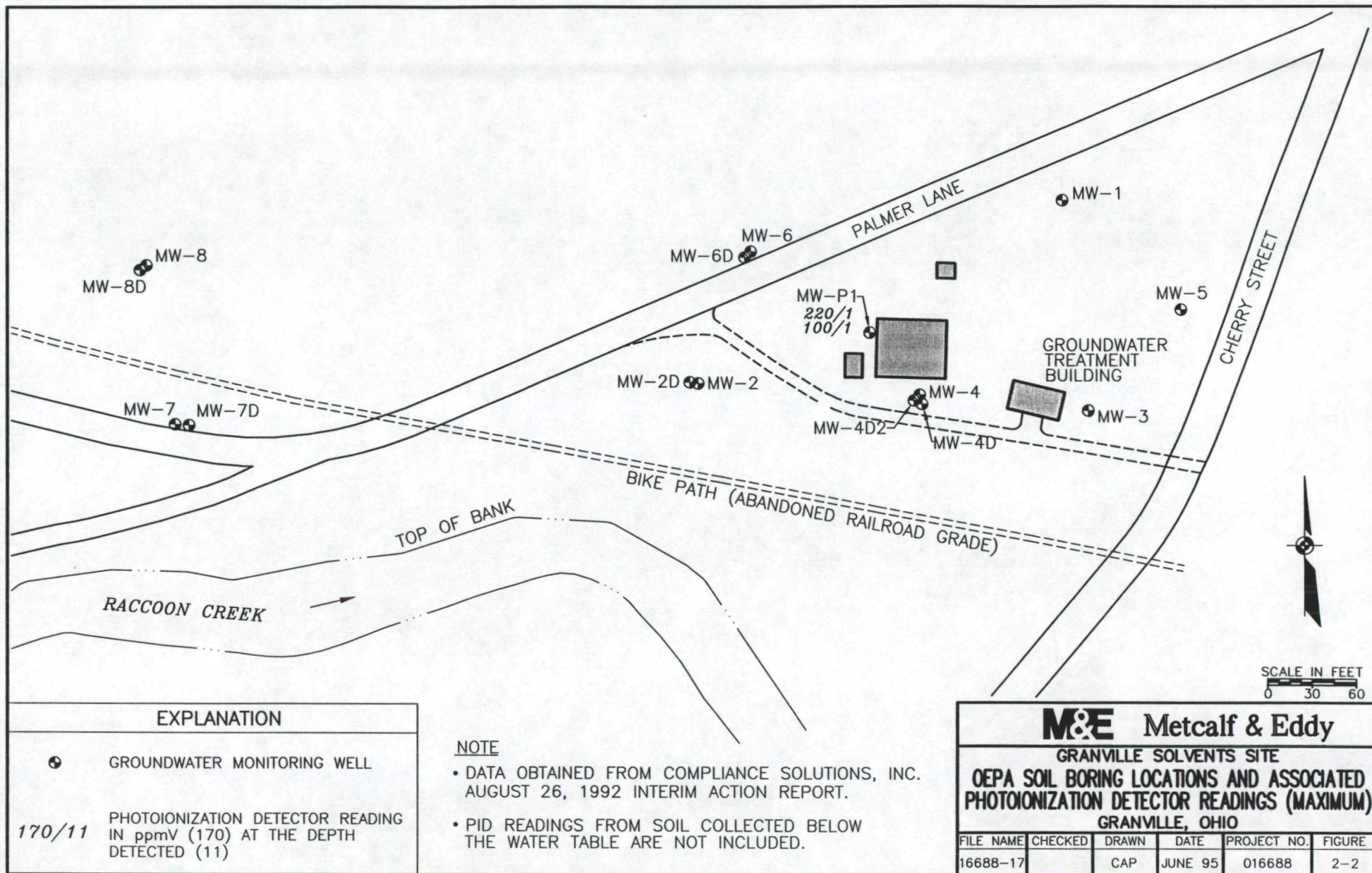
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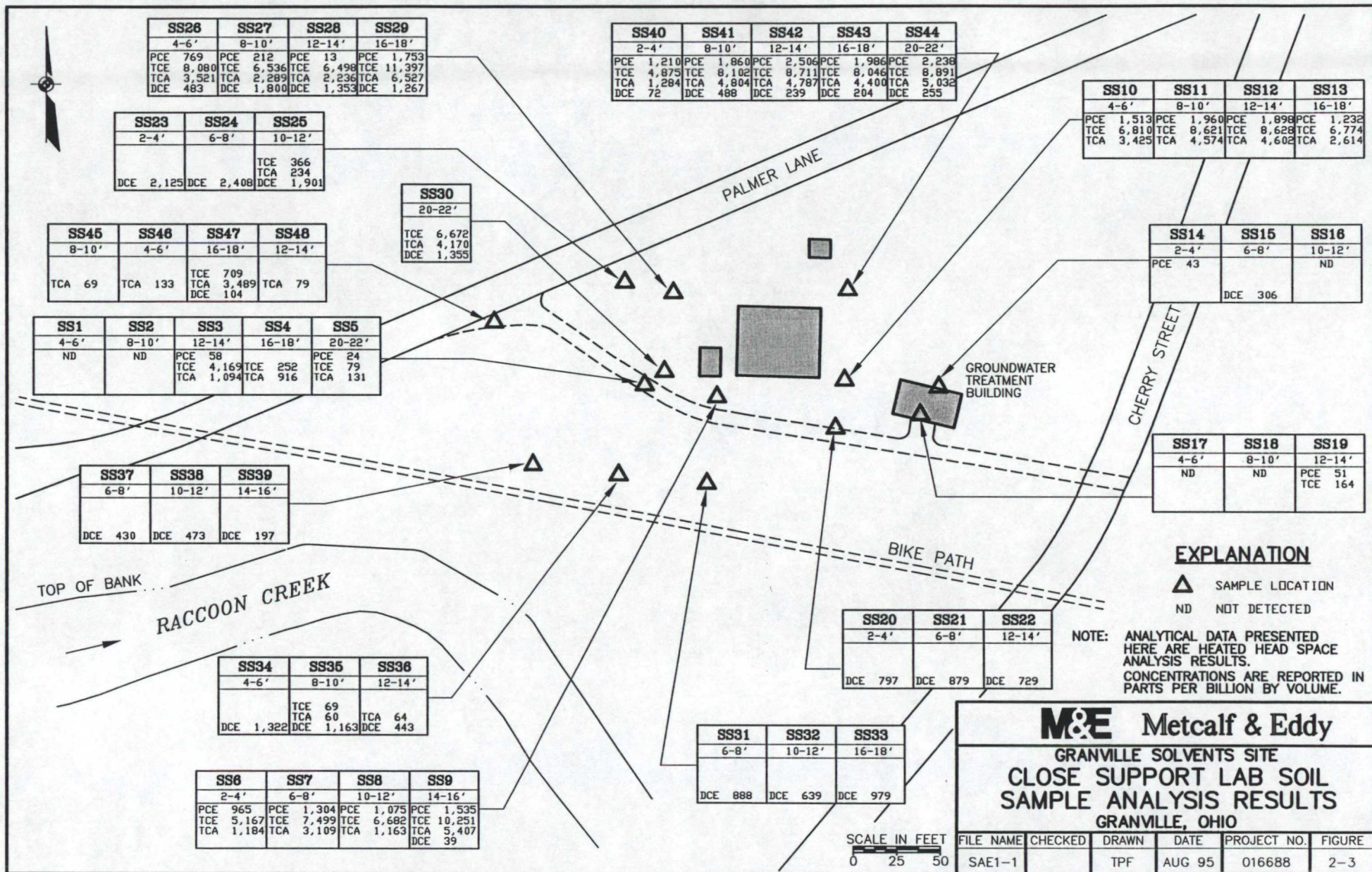
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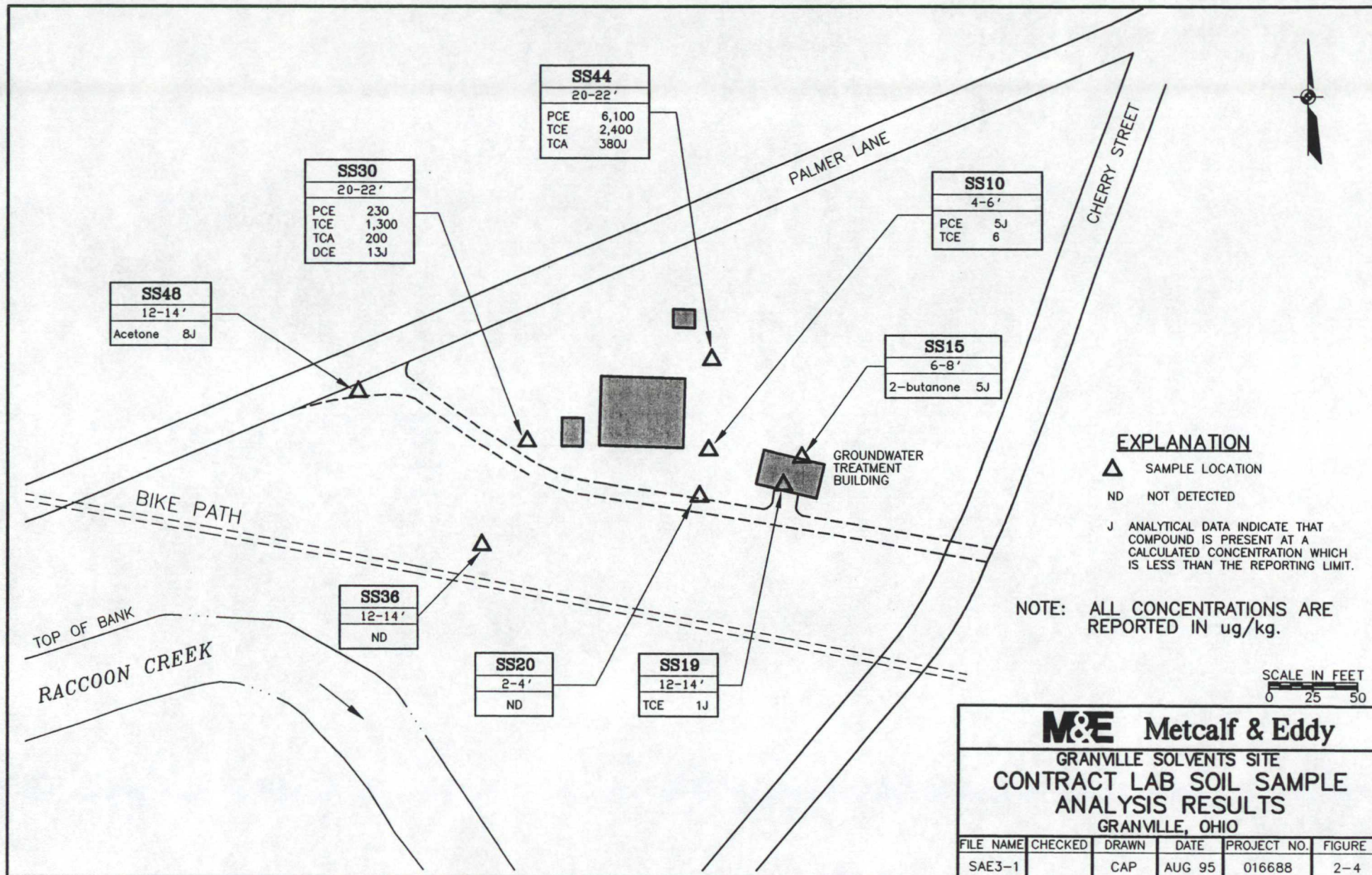
M&E Metcalf & Eddy

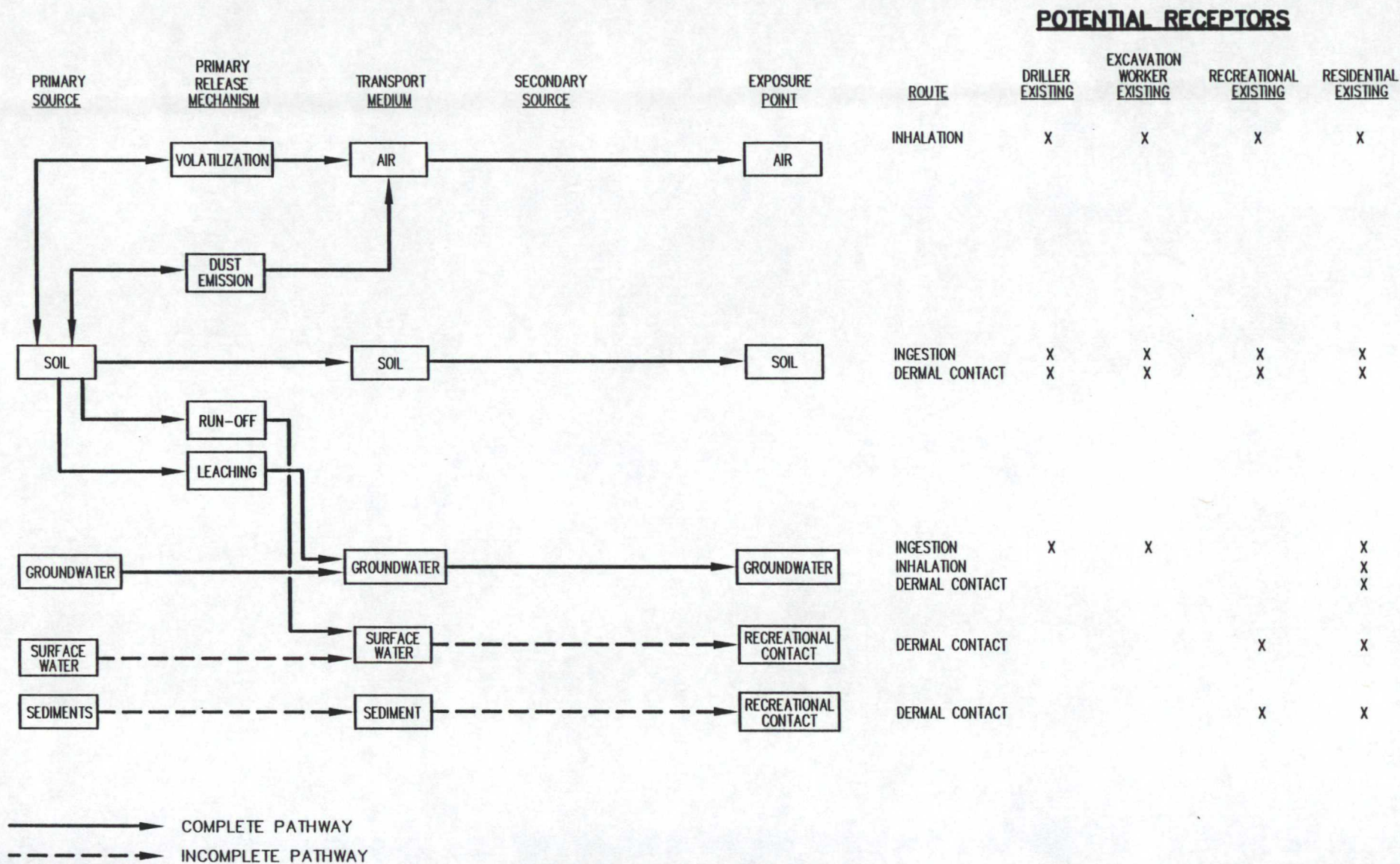
GRANVILLE SOLVENTS SITE
GROUNDWATER POTENTIOMETRIC SURFACE MAP
JANUARY 30, 1995
GRANVILLE, OHIO

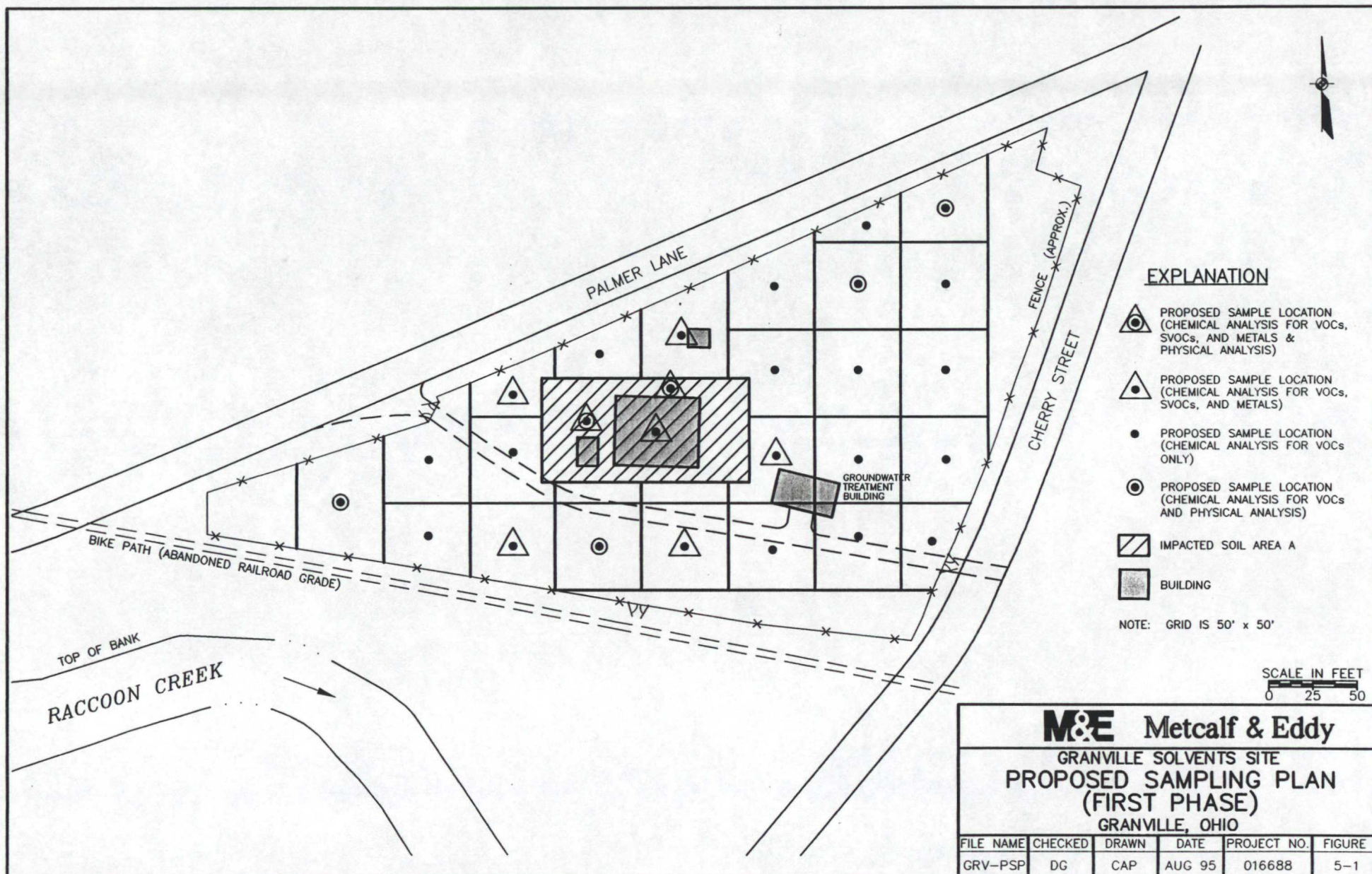
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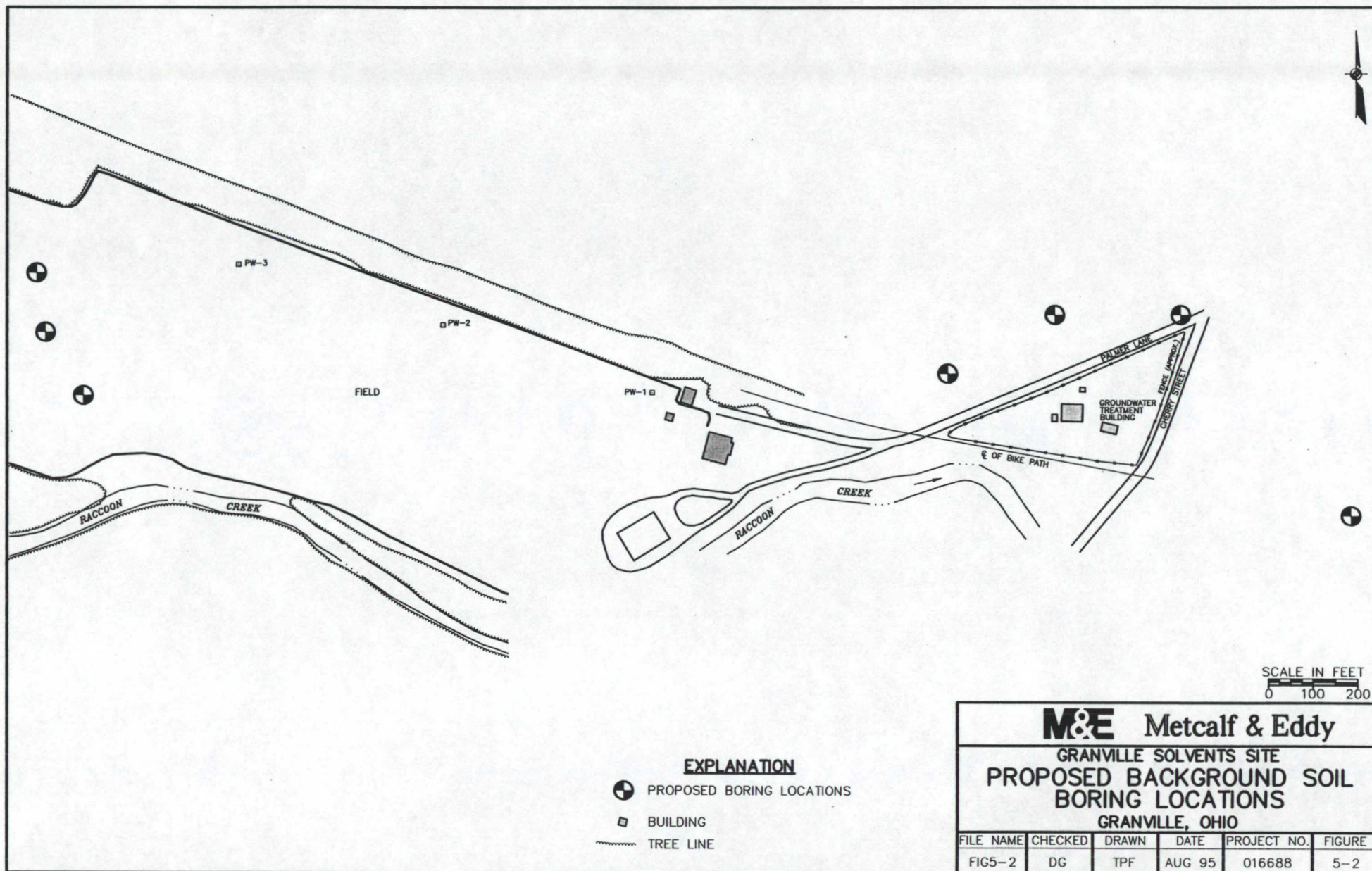












ATTACHMENT A

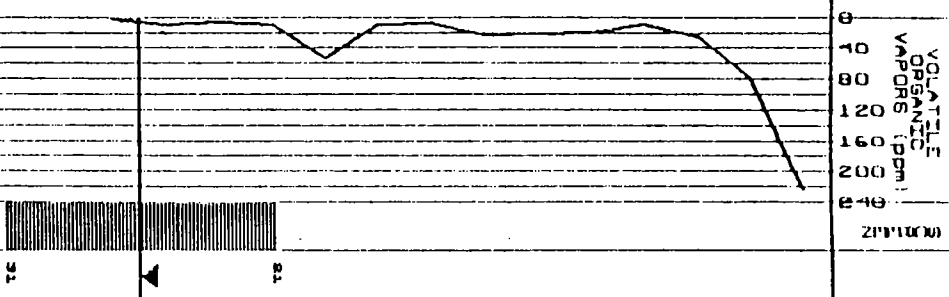
**BORING LOGS
JUNE 1991 - MAY 1992 SAMPLING INVESTIGATION**

**GRANVILLE SOLVENTS SITE
GRANVILLE, OHIO**

Boring No. 21
 DATE BEGAN: 10/10/91
 DRILLER: OHIO TESTROP INC
 TOP CASING MARK ELEV: _____
 DRILLING METHOD: Hollow Stem Flight Auger Rotary

PAGE 1 OF 1
 DATE FINISHED: 10/10/91
 LOGGED BY: D. WERN
 GUL DEPTH: 25 ft
 GUL DATE/TIME: At completion

DEPTH (ft)	SAMPLE TYPE AND NO	SPT BLOWS (ft)	REC (%)	QUALITY	DESCRIPTION	UCS	VOLATILE ORGANIC VAPORS (ppm)	REMARKS
0.00		10-12	80		CLAY Brown plastic clay, some silt, sand, gravel. Top 2" silty.	0	0	
		7 - 7	80					
-5.00		7 - 10	50		SILTY SAND Brown, some clay			
		17-15	50		SILTY SAND Some clay and gravel			
		11-11	30					
-10.00		5 - 16	0		COBBLES Large			
		20-23	2					
-15.00		18-38	40		SILTY SAND Some clay and gravel			
		39--70	30		CLAY Brown with sand and gravel			
		42-25	50		SILTY SAND with gravel, some clay			
-20.00		80-67	50		SILTY CLAY with sand, some gravel.			
		14-21	80					
-25.00		92-29	30		SILTY SAND with clay, some gravel.			
		14- 0	30					
		22-23	2		Driller "Pushed a Rock"			
-30.00		18-23	80					
-35.00								
-40.00								
-45.00								
-50.00								
-55.00								
-60.00								



COMPLIANCE SOLUTIONS -- GRANVILLE PROJECT

BOARD NO. 0-2

BORING NO. 0-2
DATE BEGAN: 1/1/22

DATULEA. Don Hegner

TOP CARBON PORK ELEV: 917.44

DEB LING METHOD, Hollow Stem Flight Auger Rotary

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PAGE

PAGE 1 OF 1
DATE RECORDED: 3/1/92

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BUL DATE/TIME: 9-17-92

DEPTH (FT)	SAMPLE TYPE AND NO	SPT BLOW COUNT	REMARKS
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COMPLIANCE SOLUTIONS -- GRANVILLE PROJECT

BORING NO: 20
 DATE BEGAN: 1/2/92
 DATE FINISHED: 1/6/92
 DRILLER: Don Hopper
 LOADED BY: B. Hopper
 TOP CASING MARK ELEV: 225.12'
 BUL. DEPTH: 25.50' (220.62' TO 250.12' SLK 300')
 DRILLING METHOD: Hollow Stem Flight Auger Rotary
 GUL DATE/TIME: 9-17-92
 NOTES: Section of well to top of MC 35.25' is

DEPTH (FT)	SAMPLE TYPE (MC NO)	SOIL TYPE (MC)	TEST	ANALYSIS	DESCRIPTION	UNIT	WATER CONTENT (%)	VOLATILE ORGANIC COMPOUNDS (ppm)	REMARKS
0.00					WATER SILT. Brown to reddish brown, moist with gravel	ML			
5.00									
10.00									
15.00					COBBLE or boulder SILT SAND Brown moist, fine sand.	GR			
20.00					CLAY Light grey, firm moist.	OL			
25.00					GRAVELLY SAND Brown moist, coarse sand	SM			
30.00					SAND Brown, wet, very coarse sand.	SP			
35.00					SAND Brown, wet, with gravel, traces grey clay	SM			
40.00					SAND Brown, wet, with coarse gravel	SM			
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BORING NO: 40
DATE BEGAN: 6/26/91
DRILLER: OHIO TESTBOR INC
TOP CABING MARK ELEV: 917.16'
DRILLING METHOD: Hollow Stem Flight Auger Rotary

PAGE 1 OF 1
DATE FINISHED: 6/26/91
LOGGED BY: J. HEIN
GUL DEPTH: 20.5 ft
BWL DATE/TIME: At completion

NOTES:

DEPTH (ft)	SAMPLE TYPE AND NO	SPT BLows Ft	REC (X)	LOG C-LOG	DESCRIPTION	US S	VOLATILE ORGANIC VAPORS (ppm)	SCHEMATIC	REMARKS
0.00		38-38	33		SILT Brown, with clay and sandy gravel top 3' crushed stone	0	0		
	15-11	20				0	0		
-5.00	0-14	23			SILTY SAND Brown, some clay	0	0		
	-	33				0	0		
	22-23	33			SILTY SAND with gravel, some metal bits.	0	0		
-10.00	28-30	33			SILTY SAND Brown, some gravel.	0	0		
	28-34	22				0	0		
-15.00	23-36	33			SANDY GRAVEL with silt.	0	0		
	29-40	20			SILTY SAND Brown, some clay.	0	0		
	27-42	22			SILTY SAND Brown, some gravel	0	0		
-20.00	41-51	25			SANDY GRAVEL Brown, some silt	0	0		
	14-17	33			SILTY CLAY with sand, some gravel.	0	0		
-25.00	24-40	33			SILT Brown, with gray-green clay gravel and sand.	0	0		
	41-48	25				0	0		
-30.00	38-45	33				0	0		
	33-48	20			SILTY SAND Brown, some clay and gravel.	0	0		
	41-62	33			SILT Brown, with sand and gravel	0	0		
-35.00	41-38	22			SANDY GRAVEL with silt and clay.	0	0		
	41-39	23				0	0		
	41-39	23			SILTY CLAY with sand.	0	0		
-40.00						0	0		
-45.00						0	0		
-50.00						0	0		
-55.00						0	0		
-60.00						0	0		

CONTINUOUS LOGGING - DRILLING RECORD

BORING NO: 5 PAGE 1 OF 1
 DATE BEGAN: 6/27/91 DATE FINISHED: 6/27/91
 DRILLER: DRILL TESTBOR INC LOGGED BY: D. WERN
 TOP CASING MARK ELEV: 922.15' GUL DEPTH: 22 ft
 DRILLING METHOD: Hollow Stem Flight Auger Rotary GUL DATE/TIME: At completion

DEPTH (FT)	SAMPLE TYPE AND NO.	SPT BLows per ft	REF (L)	LOG TYPE	DESCRIPTION	SCALE	VOLATILE ORGANIC COMPOUNDS (ppm)	REMARKS
0.00	4 - 8	79			SANDY SILT. Brown, some gravel.			
	10-17	80			SANDY SILT. Brown			
5.00	8 - 7	71						
	11-12	71			SANDY SILT. Brown, trace clay			
10.00	80-18	80			SANDY SILT. Some gravel, trace clay.			
	5 - 4	88			SILT. Brown, some sand.			
15.00	18-11	87			SILT. SAND with clay.			
	88-31	88						
20.00	88-30	73			SANDY GRAVEL. Brown, with silt.			
	18-18	80						
	03-32	88			SANDY GRAVEL. Brown, with silt.			
25.00	88-40	17			SANDY SILT. Brown, with gravel.			
	80-66	18			SANDY GRAVEL. Brown, with silt.			
	41-37	80						
30.00	13-05	38						
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COMPLIANCE SOLUTIONS -- GRANVILLE PROJECT

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DATE RECD: 3/6/82

DRUTLER, Don Hepner

TOP CORNER MARK ELEV: 226.96

[illegible]

2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066 2067 2068 2069 2070 2071 2072 2073 2074 2075 2076 2077 2078 2079 2080 2081 2082 2083 2084 2085 2086 2087 2088 2089 2090 2091 2092 2093 2094 2095 2096 2097 2098 2099 2100 2101 2102 2103 2104 2105 2106 2107 2108 2109 2110 2111 2112 2113 2114 2115 2116 2117 2118 2119 2120 2121 2122 2123 2124 2125 2126 2127 2128 2129 2130 2131 2132 2133 2134 2135 2136 2137 2138 2139 2140 2141 2142 2143 2144 2145 2146 2147 2148 2149 2150 2151 2152 2153 2154 2155 2156 2157 2158 2159 2160 2161 2162 2163 2164 2165 2166 2167 2168 2169 2170 2171 2172 2173 2174 2175 2176 2177 2178 2179 2180 2181 2182 2183 2184 2185 2186 2187 2188 2189 2190 2191 2192 2193 2194 2195 2196 2197 2198 2199 2200 2201 2202 2203 2204 2205 2206 2207 2208 2209 2210 2211 2212 2213 2214 2215 2216 2217 2218 2219 2220 2221 2222 2223 2224 2225 2226 2227 2228 2229 2230 2231 2232 2233 2234 2235 2236 2237 2238 2239 2240 2241 2242 2243 2244 2245 2246 2247 2248 2249 2250 2251 2252 2253 2254 2255 2256 2257 2258 2259 2260 2261 2262 2263 2264 2265 2266 2267 2268 2269 2270 2271 2272 2273 2274 2275 2276 2277 2278 2279 2280 2281 2282 2283 2284 2285 2286 2287 2288 2289 2290 2291 2292 2293 2294 2295 2296 2297 2298 2299 2300 2301 2302 2303 2304 2305 2306 2307 2308 2309 2310 2311 2312 2313 2314 2315 2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328 2329 2330 2331 2332 2333 2334 2335 2336 2337 2338 2339 2340 2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352 2353 2354 2355 2356 2357 2358 2359 2360 2361 2362 2363 2364 2365 2366 2367 2368 2369 2370 2371 2372 2373 2374 2375 2376 2377 2378 2379 2380 2381 2382 2383 2384 2385 2386 2387 2388 2389 2390 2391 2392 2393 2394 2395 2396 2397 2398 2399 2400 2401 2402 2403 2404 2405 2406 2407 2408 2409 2410 2411 2412 2413 2414 2415 2416 2417 2418 2419 2420 2421 2422 2423 2424 2425 2426 2427 2428 2429 2430 2431 2432 2433 2434 2435 2436 2437 2438 2439 2440 2441 2442 2443 2444 2445 2446 2447 2448 2449 2450 2451 2452 2453 2454 2455 2456 2457 2458 2459 2460 2461 2462 2463 2464 2465 2466 2467 2468 2469 2470 2471 2472 2473 2474 2475 2476 2477 2478 2479 2480 2481 2482 2483 2484 2485 2486 2487 2488 2489 2490 2491 2492 2493 2494 2495 2496 2497 2498 2499 2500 2501 2502 2503 2504 2505 2506 2507 2508 2509 2510 2511 2512 2513 2514 2515 2516 2517 2518 2519 2520 2521 2522 2523 2524 2525 2526 2527 2528 2529 2530 2531 2532 2533 2534 2535 2536 2537 2538 2539 2540 2541 2542 2543 2544 2545 2546 2547 2548 2549 2550 2551 2552 2553 2554 2555 2556 2557 2558 2559 2560 2561 2562 2563 2564 2565 2566 2567 2568 2569 2570 2571 2572 2573 2574 2575 2576 2577 2578 2579 2580 2581 2582 2583 2584 2585 2586 2587 2588 2589 2590 2591 2592 2593 2594 2595 2596 2597 2598 2599 2600 2601 2602 2603 2604 2605 2606 2607 2608 2609 2610 2611 2612 2613 2614 2615 2616 2617 2618 2619 2620 2621 2622 2623 2624 2625 2626 2627 2628 2629 2630 2631 2632 2633 2634 2635 2636 2637 2638 2639 2640 2641 2642 2643 2644 2645 2646 2647 2648 2649 2650 2651 2652 2653 2654 2655 2656 2657 2658 2659 2660 2661 2662 2663 2664 2665 2666 2667 2668 2669 2670 2671 2672 2673 2674 2675 2676 2677 2678 2679 2680 2681 2682 2683 2684 2685 2686 2687 2688 2689 2690 2691 2692 2693 2694 2695 2696 2697 2698 2699 2700 2701 2702 2703 2704 2705 2706 2707 2708 2709 2710 2711 2712 2713 2714 2715 2716 2717 2718 2719 2720 2721 2722 2723 2724 2725 2726 2727 2728 2729 2730 2731 2732 2733 2734 2735 2736 2737 2738 2739 2740 2741 2742 2743 2744 2745 2746 2747 2748 2749 2750 2751 2752 2753 2754 2755 2756 2757 2758 2759 2760 2761 2762 2763 2764 2765 2766 2767 2768 2769 2770 2771 2772 2773 2774 2775 2776 2777 2778 2779 2780 2781 2782 2783 2784 2785 2786 2787 2788 2789 2790 2791 2792 2793 2794 2795 2796 2797 2798 2799 2800 2801 2802 2803 2804 2805 2806 2807 2808 2809 2810 2811 2812 2813 2814 2815 2816 2817 2818

W

DATE RECEIVED: 5/6/95

[illegible]

7MG HUJ20 9C SC

344L DATE/TIME: 9-17-92

FLY DEPTH (FT)	SAMPLE NO. AND NO.	SOIL CLASS.	REL. DENSITY	UNIT WEIGHT	DESCRIPTION	STRAIN	VOLATILE ORGANIC VAPORE (POB)	REMARKS
0.00					CLAY, SILT, brown, moist, trace gravel top 8" crushed stone and organic top	2	900	
-5.00	1						417	
-10.00					SILT SAND, brown, moist, with gravel and some clay	3	333	
-15.00	2						250	
-20.00					SANDY GRAVEL, brown, moist to wet, oolitic	4	167	
-25.00	3						9	
-30.00								
-35.00	4							
-40.00					SAND, brown, wet, coarse, with gravel and trace silt	5		
-45.00	5							
-50.00								
-55.00	6				GRAVEL, brown, wet, well sorted, some sand and silt, 5 inch well rounded gravel	6		
-60.00								
-65.00	7				SAND, brown, wet, trace gravel, few black silt bits	7		
-70.00								
-75.00	8							
-80.00					SAND, dark brown, wet, with gravel, trace silt	8		
-85.00	9							
-90.00								
-95.00	10							

BORING NO: 10
 DATE BEGAN: 11/5/91
 DRILLER: OHIO TESTBOR INC
 TOP CASING MARK ELEV: 916.68'
 DRILLING METHOD: Hollow Stem Flight Auger Rotary

PAGE 1 OF 1
 DATE FINISHED:
 LOGGED BY: J. D. HEIN
 BUL DEPTH: 18 ft
 BUL DATE/TIME: At Completion

DEPTH (ft)	SAMPLE AND NO.	SPT BLows per ft	REC (%)	MOISTURE	DESCRIPTION	DOCS	VOLATILE ORGANIC VAPORS (ppm)	WATER CONTENT	REMARKS
0.00		12-13	100		SANDY SILT: Brown, with gravel.				
	13-16	79			SILTY SAND: Brown, with gravel.				
-5.00	16-19	100							
	20-21	100							
	21-29	82							
-10.00	29-36	100			SILT: Brown, with sand and gravel.				
	36-39	82			SILTY SAND: Brown.				
-15.00	39-41	13			SILTY SAND: Brown, some gravel.				
	41-50	36							
	14-18	26							
-20.00	18-18	26			SILTY SAND.				
	18-18	30							
-25.00	18-11	23			CLAY: Gray, with silt and sand.				
	18-24	89			SILTY SAND: Brown, occ. cobble.				
	100	0							
-30.00	32-34	100							
	36-31	42							
-35.00	35-50	75							
	42-80	33							
-40.00	8-80	17			SANDY GRAVEL: Brown, with silt.				
-45.00									
-50.00									
-55.00									
-60.00									

86.32

86.32

7

COMPLIANCE SOLUTIONS -- GRANVILLE PROJECT

BORING NO: 8

DATE BORING: 5/7/92

DRILLER: Don Hepper

TOP CASING MARK ELEV: 328.9

DRILLING METHOD: Hollow Stem Flight Auger Borehole

PAGE 1 OF 1

DATE RECORDED: 5/7/92

LOGGED BY: D. Knecht

BUL DEPTH: 30.5 ft (FROM TOP CASING ELEV 307.4)

BUL DATE/TIME: 9-17-92

NOTES: Section 7, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64, 66, 68, 70, 72, 74, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100

DEPTH (ft)	RANGE AND NO	SOIL TYPE	TEST	MOISTURE	DESCRIPTION	WATER	VOLATILE ORGANICS (ppm)	REMARKS
0.00	1.0	1.0	1.0	1.0	CLAYEY SILT: Brown moist some organic	1.0	1.0	
5.00	1.0	1.0	1.0	1.0	SILT CLAY: Light brown, moist, with fine gravel, some reddish clay bits	1.0	1.0	
10.00	1.0	1.0	1.0	1.0	SILT: Brown moist with gravel, some organic, some iron staining	1.0	1.0	
15.00	1.0	1.0	1.0	1.0	GRAVELLY SAND: Light brown to tan, gray, many cobble, some iron staining	1.0	1.0	
20.00	1.0	1.0	1.0	1.0	GRAVELLY SAND: Light brown to tan, gray, traces clay and organic, some iron staining	1.0	1.0	
25.00	1.0	1.0	1.0	1.0	SILT SAND: Brown moist to wet, with gravel	1.0	1.0	
30.00	1.0	1.0	1.0	1.0	GRAVELLY SAND: Dark brown wet, with gravel and silty cobble	1.0	1.0	
35.00	1.0	1.0	1.0	1.0		1.0	1.0	
40.00	1.0	1.0	1.0	1.0		1.0	1.0	
45.00	1.0	1.0	1.0	1.0		1.0	1.0	
50.00	1.0	1.0	1.0	1.0		1.0	1.0	
55.00	1.0	1.0	1.0	1.0		1.0	1.0	
60.00	1.0	1.0	1.0	1.0		1.0	1.0	
65.00	1.0	1.0	1.0	1.0		1.0	1.0	
70.00	1.0	1.0	1.0	1.0		1.0	1.0	
75.00	1.0	1.0	1.0	1.0		1.0	1.0	
80.00	1.0	1.0	1.0	1.0		1.0	1.0	
85.00	1.0	1.0	1.0	1.0		1.0	1.0	
90.00	1.0	1.0	1.0	1.0		1.0	1.0	
95.00	1.0	1.0	1.0	1.0		1.0	1.0	
100.00	1.0	1.0	1.0	1.0		1.0	1.0	

COMPLIANCE SOLUTIONS -- GRANVILLE PROJECT

BORING NO: 50
 DATE BORING: 5/7/92
 DRILLER: Don Wagner
 TOP CASING MARK ELEV: 223.22
 DRILLING METHOD: Hollow Stem Flight Auger Rotary
 NOTES: Bottom of well is top of PVC pipe.

PAGE 1 OF 1
 DATE REVISED: 5/7/92
 LOGGED BY: D. Kneibbus
 BUL DEPTH: 30.0' (FROM TOP CASING ELEV. 223)
 BUL DATE/TIME: 9-17-92

DEPTH (ft)	SAMPLE NO.	SPR LOG	REF	DEPTH (ft)	DESCRIPTION	CHL	VELOC VAPOR VAPOR	VELOC VAPOR VAPOR	VELOC VAPOR VAPOR	REMARKS
0.0					DATEY SILT Brown moist some gravel.	7	0	5	31	
5.0					GRAVELLY SAND Brown moist to wet. with silt and some clay.	8	0	5	31	
10.0										
15.0										
20.0										
25.0										
30.0										
35.0										
40.0										
45.0										
50.0										
55.0										
60.0										
65.0										
70.0										
75.0										
80.0										
85.0										
90.0										
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110.0										
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120.0										
125.0										
130.0										
135.0										
140.0										
145.0										
150.0										
155.0										
160.0										
165.0										
170.0										
175.0										
180.0										
185.0										
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205.0										
210.0										
215.0										
220.0										
225.0										
230.0										
235.0										
240.0										
245.0										
250.0										
255.0										
260.0										
265.0										
270.0										
275.0										
280.0										
285.0										
290.0										
295.0										
300.0										
305.0										
310.0										
315.0										
320.0										
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405.0										
410.0										
415.0										
420.0										
425.0										
430.0										
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465.0										
470.0										
475.0										
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485.0										
490.0										
495.0										
500.0										

Notes: 1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 227. 228. 229. 230. 231. 232. 233. 234. 235. 236. 237. 238. 239. 240. 241. 242. 243. 244. 245. 246. 247. 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. 261. 262. 263. 264. 265. 266. 267. 268. 269. 270. 271. 272. 273. 274. 275. 276. 277. 278. 279. 280. 281. 282. 283. 284. 285. 286. 287. 288. 289. 290. 291. 292. 293. 294. 295. 296. 297. 298. 299. 300. 301. 302. 303. 304. 305. 306. 307. 308. 309. 310. 311. 312. 313. 314. 315. 316. 317. 318. 319. 320. 321. 322. 323. 324. 325. 326. 327. 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. 343. 344. 345. 346. 347. 348. 349. 350. 351. 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. 364. 365. 366. 367. 368. 369. 370. 371. 372. 373. 374. 375. 376. 377. 378. 379. 380. 381. 382. 383. 384. 385. 386. 387. 388. 389. 390. 391. 392. 393. 394. 395. 396. 397. 398. 399. 400. 401. 402. 403. 404. 405. 406. 407. 408. 409. 410. 411. 412. 413. 414. 415. 416. 417. 418. 419. 420. 421. 422. 423. 424. 425. 426. 427. 428. 429. 430. 431. 432. 433. 434. 435. 436. 437. 438. 439. 440. 441. 442. 443. 444. 445. 446. 447. 448. 449. 450. 451. 452. 453. 454. 455. 456. 457. 458. 459. 460. 461. 462. 463. 464. 465. 466. 467. 468. 469. 470. 471. 472. 473. 474. 475. 476. 477. 478. 479. 480. 481. 482. 483. 484. 485. 486. 487. 488. 489. 490. 491. 492. 493. 494. 495. 496. 497. 498. 499. 500. 501. 502. 503. 504. 505. 506. 507. 508. 509. 510. 511. 512. 513. 514. 515. 516. 517. 518. 519. 520. 521. 522. 523. 524. 525. 526. 527. 528. 529. 530. 531. 532. 533. 534. 535. 536. 537. 538. 539. 540. 541. 542. 543. 544. 545. 546. 547. 548. 549. 550. 551. 552. 553. 554. 555. 556. 557. 558. 559. 560. 561. 562. 563. 564. 565. 566. 567. 568. 569. 570. 571. 572. 573. 574. 575. 576. 577. 578. 579. 580. 581. 582. 583. 584. 585. 586. 587. 588. 589. 590. 591. 592. 593. 594. 595. 596. 597. 598. 599. 600. 601. 602. 603. 604. 605. 606. 607. 608. 609. 610. 611. 612. 613. 614. 615. 616. 617. 618. 619. 620. 621. 622. 623. 624. 625. 626. 627. 628. 629. 630. 631. 632. 633. 634. 635. 636. 637. 638. 639. 640. 641. 642. 643. 644. 645. 646. 647. 648. 649. 650. 651. 652. 653. 654. 655. 656. 657. 658. 659. 660. 661. 662. 663. 664. 665. 666. 667. 668. 669. 670. 671. 672. 673. 674. 675. 676. 677. 678. 679. 680. 681. 682. 683. 684. 685. 686. 687. 688. 689. 690. 691. 692. 693. 694. 695. 696. 697. 698. 699. 700. 701. 702. 703. 704. 705. 706. 707. 708. 709. 710. 711. 712. 713. 714. 715. 716. 717. 718. 719. 720. 721. 722. 723. 724. 725. 726. 727. 728. 729. 730. 731. 732. 733. 734. 735. 736. 737. 738. 739. 740. 741. 742. 743. 744. 745. 746. 747. 748. 749. 750. 751. 752. 753. 754. 755. 756. 757. 758. 759. 760. 761. 762. 763. 764. 765. 766. 767. 768. 769. 770. 771. 772. 773. 774. 775. 776. 777. 778. 779. 780. 781. 782. 783. 784. 785. 786. 787. 788. 789. 790. 791. 792. 793. 794. 795. 796. 797. 798. 799. 800. 801. 802. 803. 804. 805. 806. 807. 808. 809. 810. 811. 812. 813. 814. 815. 816. 817. 818. 819. 820. 821. 822. 823. 824. 825. 826. 827. 828. 829. 830. 831. 832. 833. 834. 835. 836. 837. 838. 839. 840. 841. 842. 843. 844. 845. 846. 847. 848. 849. 850. 851. 852. 853. 854. 855. 856. 857. 858. 859. 860. 861. 862. 863. 864. 865. 866. 867. 868. 869. 870. 871. 872. 873. 874. 875. 876. 877. 878. 879. 880. 881. 882. 883. 884. 885. 886. 887. 888. 889. 890. 891. 892. 893. 894. 895. 896. 897. 898. 899. 900. 901. 902. 903. 904. 905. 906. 907. 908. 909. 910. 911. 912. 913. 914. 915. 916. 917. 918. 919. 920. 921. 922. 923. 924. 925. 926. 927. 928. 929. 930. 931. 932. 933. 934. 935. 936. 937. 938. 939. 940. 941. 942. 943. 944. 945. 946. 947. 948. 949. 950. 951. 952. 953. 954. 955. 956. 957. 958. 959. 960. 961. 962. 963. 964. 965. 966. 967. 968. 969. 970. 971. 972. 973. 974. 975. 976. 977. 978. 979. 980. 981. 982. 983. 984. 985. 986. 987. 988. 989. 990. 991. 992. 993. 994. 995. 996. 997. 998. 999. 1000. 1001. 1002. 1003. 1004. 1005. 1006. 1007. 1008. 1009. 1010. 1011. 1012. 1013. 1014. 1015. 1016. 1017. 1018. 1019. 1020. 1021. 1022. 1023. 1024. 1025. 1026. 1027. 1028. 1029. 1030. 1031. 1032. 1033. 1034. 1035. 1036. 1037. 1038. 1039. 1040. 1041. 1042. 1043. 1044. 1045. 1046. 1047. 1048. 1049. 1050. 1051. 1052. 1053. 1054. 1055. 1056. 1057. 1058. 1059. 1060. 1061. 1062. 1063. 1064. 1065. 1066. 1067. 1068. 1069. 1070. 1071. 1072. 1073. 1074. 1075. 1076. 1077. 1078. 1079. 1080. 1081. 1082. 1083. 1084. 1085. 1086. 1087. 1088. 1089. 1090. 1091. 1092. 1093. 1094. 1095. 1096. 1097. 1098. 1099. 1100. 1101. 1102. 1103. 1104. 1105. 1106. 1107. 1108. 1109. 1110. 1111. 1112. 1113. 1114. 1115. 1116. 1117. 1118. 1119. 1120. 1121. 1122. 1123. 1124. 1125. 1126. 1127. 1128. 1129. 1130. 1131. 1132. 1133. 1134. 1135. 1136. 1137. 1138. 1139. 1140. 1141. 1142. 1143. 1144. 1145. 1146. 1147. 1148. 1149. 1150. 1151. 1152. 1153. 1154. 1155. 1156. 1157. 1158. 1159. 1160. 1161. 1162. 1163. 1164. 1165. 1166. 1167. 1168. 1169. 1170. 1171. 1172. 1173. 1174. 1175. 1176. 1177. 1178. 1179. 1180. 1181. 1182. 1183. 1184. 1185. 1186. 1187. 1188. 1189. 1190. 1191. 1192. 1193. 1194. 1195. 1196. 1197. 1198. 1199. 1200. 1201. 1202. 1203. 1204. 1205. 1206. 1207. 1208. 1209. 1210. 1211. 1212. 1213. 1214. 1215. 1216. 1217. 1218. 1219. 1220. 1221. 1222. 122

APPENDIX A

PRELIMINARY REMEDIATION GOALS FOR CHEMICALS OF POTENTIAL CONCERN IN SOIL

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1.0 DEVELOPMENT OF RISK-BASED PRELIMINARY REMEDIATION GOALS

This appendix describes the methods by which human health risk-based preliminary remediation goals (PRGs) were developed for the Granville Solvents Site (GSS). Guidance for the determination of the PRGs was based on the U.S. EPA's Human Health Evaluation Manual (HHEM), Part B: "Development of Risk-Based Preliminary Remediation Goals" (U.S. EPA, 1991, U.S. EPA, 1992). As outlined in the U.S. EPA guidance, risk-based PRGs are calculated in order to reflect the potential risk from exposure to a chemical, given a specific pathway, medium, and land-use combination. The PRGs (for direct contact with chemicals in soil and for the protection against chemical migration from soil to groundwater) were developed for the list of chemicals detected at the GSS in soil and/or groundwater. The GSS is not currently active. However, areas in the vicinity of the site are used for commercial and residential purposes. Potential receptors and specific pathways of exposures considered for the GSS are as follows:

- 1) On-Site Environmental Sampler
 - Soil ingestion
 - Inhalation of volatiles/particulates from soil
- 2) On-Site Excavation Worker
 - Soil ingestion
 - Inhalation of volatiles/particulates from soil
- 3) Off-Site Residential Adult
 - Inhalation of volatiles/particulates from soil
- 4) Off-Site Residential Child
 - Inhalation of volatiles/particulates from soil
- 5) Off-Site Adult Biker/Walker
 - Inhalation of volatiles/particulates from soil
- 6) Off-Site Child Biker/Walker
 - Inhalation of volatiles/particulates from soil

Based on the currently available information for the GSS, potential exposures to chemicals in soil (via incidental ingestion and/or inhalation of volatiles/particulates) could reasonably be expected to occur. The degree of such soil exposure would likely differ among the various receptors. However, exposure to groundwater is not expected to occur for the potential receptors identified for the site. Therefore, only site-specific PRGs for exposure to soil are developed in this Appendix. The use of the six potential receptors listed above in the calculation of soil PRGs provides a range of levels that may assist in the selection of remedial alternatives for the GSS. Tables 1 through 6 provide the chemical-specific soil PRGs for the identified receptors. Overall, the goal for the level of health protection for each of the receptor groups is the same, but the degree of exposure (i.e., duration, frequency, pathway of exposure, etc.) varies. The end result is that the PRGs are receptor-specific. In the case where one receptor is exposed less frequently or by fewer pathways (i.e., inhalation, ingestion, etc.), the risk-based PRG will be higher than for another receptor who has occasion for more frequent or multi-pathway exposures.

The PRGs are derived from calculations in which the acceptable criteria for cancer risk and noncancer hazard ($1E-06$ and 1.0 , respectively) are utilized to quantify the risk-based concentration of each chemical of concern. The objective is to determine the chemical concentration which will not result in an exceedance of the risk criteria. Calculation of the PRGs is based on the toxicity characteristic of the chemical and the receptor-specific exposure assumptions for each land-use scenario. The PRG equations utilized for the GSS are based on site-specific exposure information (when available), and U.S. EPA standard default exposure assumptions (U.S. EPA, 1991). Toxicity values for the chemicals of concern have been provided in the soil PRG tables (Tables 1 through 6). The soil PRGs were based primarily on oral and/or inhalation exposures. The cleanup goals were calculated on an exposure-specific and a chemical-specific basis. Tables 7 through 19 provide the equations and the assumptions utilized for the parameter values in the calculation of the human health soil cleanup goals.

2.0 DEVELOPMENT OF RISK-BASED PRGS FOR SOIL TO GROUNDWATER MIGRATION

The chemical concentrations in soil which will result in groundwater chemical concentrations that do not exceed a health protective criterion [i.e., a maximum contaminant level (MCL) or risk-based groundwater PRG] were derived for the GSS. These PRGs were derived based on the use of a predictive fate and transport model to characterize the potential for soil to groundwater migration of chemicals (Karickhoff, 1979). Such models were employed to estimate the relationship between soil and groundwater chemical

concentrations. Chemical-specific PRGs were then derived once the relationship between soil and groundwater chemical concentrations was predicted.

Selection of an appropriate fate and transport model is dependent upon the availability of site-specific information. For the purposes of this document, a simple, conservative relationship between the site organic carbon content and organic carbon coefficient (K_{oc}) was selected to estimate soil to groundwater migration of chemicals. Fraction organic carbon content (f_{oc}) literature values, rather than site-specific data, were used to estimate K_{oc} and, ultimately, K_d values. As additional site-specific soil physical parameters are obtained in future soil sampling investigations, model parameters will be refined to better represent fate and transport processes associated with the site.

The use of the simple, conservative relationship of K_{oc} , of course, does not provide a definitive, in-depth analysis of the complex fate and transport processes of chemicals in the subsurface environment. But, for example, the use of a generic dilution and attenuation factor (DAF) in determining soil screening levels does consider the physicochemical factors of dilution and attenuation within the saturated zone (U.S. EPA, 1994). Again, as site-specific parameters are obtained during additional soil investigations, the DAF can be refined to better describe site conditions.

The technique used to predict groundwater concentrations which hypothetically could result from concentrations in soil is based on the soil adsorption coefficient (or distribution coefficient) K_d . The K_d is defined as the ratio of the concentration adsorbed on soil surfaces to the concentration in water (Dragun 1988). The K_d model assumes that the liquid and solid phases are at equilibrium and that there is a linear relationship between solute concentrations in the liquid and solid phases. The greater the extent of adsorption, the greater the magnitude of the K_d .

The application of K_d to soil-water phase systems is subject to the following assumptions:

- The water travels through uniformly porous media.
- A rapid and reversible chemical equilibrium exists between groundwater and soils.

The K_d value for organic constituents was determined using the following equation (Karickhoff, 1979):

$$K_d = (f_{oc} * K_{oc}) \quad (1)$$

where:

K_d = Chemical-specific adsorption coefficient, l/kg

f_{oc} = Fraction organic carbon content (0.01, based on an average total organic matter of 2% for the types of soil present at the GSS. Ohio Department of Natural Resources, Soil Survey of Licking County, May 1992). The fraction organic content is determined by dividing the total organic matter value by 1.724.

K_{oc} = Chemical-specific soil organic carbon/water partition coefficient, l/kg (PDER, 1990; Jeng et. al., 1992)

The K_d can then be used to determine the partitioning of a chemical between the soil and water phase. Thus, groundwater chemical concentrations are predicted based on the K_d and the chemical concentration in soil. The following equation is taken from the EPA document "Determining Soil Response Action Levels Based on Potential Contaminant Migration to Groundwater" (U.S. EPA, 1989):

$$C_{water} = C_{soil}/K_d \quad (2)$$

where:

C_{water} = Concentration in water, mg/l

K_d = Absorption coefficient, l/kg

C_{soil} = Maximum concentration in soil, mg/kg

or:

$$C_{soil} = C_{water} \times K_d \quad (3)$$

To determine the soil PRG (C_{soil}), the equation is rearranged to solve for C_{soil} , and C_{water} is set equal to a drinking water standard, such as an MCL or risk-based action level. Thus, the equation is as follows:

$$PRG_{soil} = MCL(\text{or Risk-Based Action Level}) \times K_d \times DAF \quad (4)$$

For comparison purposes, both the chemical-specific MCL and Risk Based Action Levels developed by U.S. EPA Region IX, were utilized to derive a protective soil concentration using equation (4). The estimates of the soil concentrations are provided in Tables 20 and 21. Chemical-specific MCLs and risk based soil levels calculated using a generic DAF of 10 were employed at the GSS assuming an unconfined, unconsolidated aquifer with homogeneous and isotropic hydrologic properties underlying the

site and assuming the soils are not underlain by karst or fractured rock aquifers (U.S. EPA, 1994). Development of a more site-specific DAF may be warranted in future evaluations when more site-specific information becomes available.

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Table A-1 Risk-Based Preliminary Remediation Goals (PRGs) for an Excavation Worker for Chemicals of Concern in Soil at Granville Solvents

CHEMICAL	TOXICITY INFORMATION*				PRGs	
	CARCINOGENIC		NONCARCINOGENIC**		ORAL AND INHALATION EXPOSURE	
	SF oral per (mg/kg/day)	SF Inh per (mg/kg/day)	RfD oral (mg/kg/day)	RfD Inh (mg/kg/day)	Carcinogenic (mg/kg)	Noncarcinogenic (mg/kg)
1,1,1-Trichloroethane	NA	NA	NA	3.00E-01	ND	4.63E+05
1,1-Dichloroethane	NA	NA	1.00E+00	1.00E+00	ND	6.18E+05
1,1-Dichloroethene	6.00E-01	1.20E+00	9.00E-03	NA	3.43E+00	8.48E+03
2-Butanone	NA	NA	6.00E-01	3.00E-01	ND	1.86E+05
2-Hexanone	NA	NA	NA	NA	ND	ND
Acetone	NA	NA	1.00E+00	NA	ND	9.42E+05
Benzene	2.90E-02	2.90E-02	NA	NA	1.41E+02	ND
Bromodichloromethane	6.20E-02	NA	2.00E-02	NA	4.81E+03	1.88E+04
Bromoform	7.90E-03	3.90E-03	2.00E-01	NA	1.03E+03	1.88E+05
Carbon disulfide	NA	NA	1.00E-01	2.90E-03	ND	5.84E+03
Chloroform	6.10E-03	8.10E-02	1.00E-02	NA	5.11E+01	9.42E+03
Chloromethane	1.30E-02	6.30E-03	NA	NA	6.39E+02	ND
cis-1,2-Dichloroethene	NA	NA	1.00E-01	NA	ND	9.42E+04
Dibromochloromethane	8.40E-02	NA	2.00E-01	NA	3.55E+03	1.88E+05
Ethylbenzene	NA	NA	1.00E-01	3.00E-01	ND	5.72E+05
m- & p Xylenes	NA	NA	2.00E+00	3.00E-01	ND	6.03E+05
o-Xylenes	NA	NA	2.00E+00	3.00E-01	ND	6.03E+05
Tetrachloroethene	5.20E-02	2.00E-03	1.00E-01	NA	1.52E+03	1.71E+05
Toluene	NA	NA	2.00E+00	3.00E-01	ND	7.80E+05
trans-1,2-Dichloroethene	NA	NA	2.00E-01	NA	ND	2.92E+05
Trichloroethene	1.10E-02	6.00E-03	NA	NA	6.73E+02	ND
Vinyl chloride	1.90E+00	3.00E-01	NA	NA	1.27E+01	ND

NA - Not Available

ND - Not Determined

SF oral - Slope Factor-oral exposure

SF Inh - Slope Factor-Inhalation exposure

RfD oral - Reference Dose-oral exposure

RfD Inh - Reference Dose-Inhalation exposure

* Toxicity Information Sources: Integrated Risk Information System (IRIS, Accessed 4/5/95); and Health Effects Assessment Summary Tables (1994)

** Noncarcinogenic toxicity values are subchronic because exposure duration is less than seven years.

Note: Oral toxicity values were also used for inhalation toxicity values in the PRG calculation when inhalation toxicity values were not available (route-to-route extrapolation)

Table A-2 Risk-Based Preliminary Remediation Goals (PRGs) for an Environmental Sampler for Chemicals of Concern in Soil at Granville Solvents

CHEMICAL	TOXICITY INFORMATION*				PRGs	
	CARCINOGENIC		NONCARCINOGENIC**		ORAL AND INHALATION EXPOSURE	
	SF oral per (mg/kg/day)	SF Inh per (mg/kg/day)	RfD oral (mg/kg/day)	RfD Inh (mg/kg/day)	Carcinogenic (mg/kg)	Noncarcinogenic (mg/kg)
1,1,1-Trichloroethane	NA	NA	NA	3.00E-01	ND	9.26E+05
1,1-Dichloroethane	NA	NA	1.00E+00	1.00E+00	ND	3.09E+06
1,1-Dichloroethene	6.00E-01	1.20E+00	9.00E-03	NA	4.42E+00	1.92E+06
2-Butanone	NA	NA	6.00E-01	3.00E-01	ND	9.26E+05
2-Hexanone	NA	NA	NA	NA	ND	ND
Acetone	NA	NA	1.00E+00	NA	ND	2.13E+08
Benzene	2.90E-02	2.90E-02	NA	NA	1.82E+02	ND
Bromodichloromethane	6.20E-02	NA	2.00E-02	NA	9.62E+03	4.26E+06
Bromoform	7.90E-03	3.90E-03	2.00E-01	NA	1.34E+03	4.26E+07
Carbon disulfide	NA	NA	1.00E-01	2.90E-03	ND	9.08E+03
Chloroform	6.10E-03	8.10E-02	1.00E-02	NA	6.57E+01	2.13E+06
Chloromethane	1.30E-02	6.30E-03	NA	NA	8.30E+02	ND
cis-1,2-Dichloroethene	NA	NA	1.00E-01	NA	ND	2.13E+07
Dibromochloromethane	8.40E-02	NA	2.00E-01	NA	7.10E+03	4.26E+07
Ethylbenzene	NA	NA	1.00E-01	3.00E-01	ND	9.00E+05
m- & p Xylenes	NA	NA	2.00E+00	3.00E-01	ND	9.37E+05
o-Xylenes	NA	NA	2.00E+00	3.00E-01	ND	9.37E+05
Tetrachloroethene	5.20E-02	2.00E-03	1.00E-01	NA	2.16E+03	2.13E+07
Toluene	NA	NA	2.00E+00	3.00E-01	ND	9.37E+05
trans-1,2-Dichloroethene	NA	NA	2.00E-01	NA	ND	4.26E+07
Trichloroethene	1.10E-02	6.00E-03	NA	NA	8.73E+02	ND
Vinyl chloride	1.90E+00	3.00E-01	NA	NA	1.68E+01	ND

NA - Not Available

ND - Not Determined

SF oral - Slope Factor-oral exposure

SF Inh - Slope Factor-Inhalation exposure

RfD oral - Reference Dose-oral exposure

RfD Inh - Reference Dose-Inhalation exposure

* Toxicity Information Sources: Integrated Risk Information System (IRIS, Accessed 4/5/95); and Health Effects Assessment Summary Tables (1994)

** Noncarcinogenic toxicity values are subchronic because exposure duration is less than seven years.

Note: Oral toxicity values were also used for inhalation toxicity values in the PRG calculation when inhalation toxicity values were not available (route-to-route extrapolation)

Table A-3 Risk-Based Soil Preliminary Remediation Goals (PRGs) for an Adult Residential Scenario – Inhalation Pathway

CHEMICAL	Toxicity Information**		PRGs	
	Carcinogenic	Noncarcinogenic*	Inhalation Exposure	
	SF inh per (mg/kg/day)	RfD inh (mg/kg/day)	Carcinogenic (mg/kg)	Noncarcinogenic (mg/kg)
1,1,1-Trichloroethane	NA	6.0E-01	ND	1.71E+04
1,1-Dichloroethene	1.2E+00	NA	3.37E-02	ND
1,1-Dichloroethane	NA	1.0E+00	ND	1.14E+04
2-Butanone	NA	3.0E-01	ND	1.60E+04
2-Hexanone	NA	NA	ND	ND
Acetone	NA	1.0E+00	ND	3.08E+04
Benzene	2.9E-02	NA	2.91E+00	ND
Bromodichloromethane	6.2E-02	2.0E-02	1.14E-01	6.04E+01
Bromoform	3.9E-03	NA	9.74E+01	ND
Carbon disulfide	NA	2.9E-03	ND	1.07E+02
Chloroform	8.1E-02	NA	9.07E-01	ND
Chloromethane	6.3E-03	NA	4.82E+00	ND
cis-1,2-Dichloroethene	NA	1.0E-01	ND	1.29E+03
Dibromochloromethane	3.4E-02	2.0E-01	2.80E+00	2.02E+04
Ethylbenzene	NA	3.0E-01	ND	1.66E+04
m- & p Xylenes	NA	3.0E-01	ND	2.38E+04
o-Xylenes	NA	3.0E-01	ND	2.00E+04
Tetrachloroethene	2.0E-03	NA	3.71E+01	ND
Toluene	NA	3.0E-01	ND	1.42E+04
trans-1,2-Dichloroethene	NA	2.0E-02	ND	5.38E+02
Trichloroethene	6.0E-03	NA	1.25E+01	ND
Vinyl chloride	3.0E-01	NA	2.47E-03	ND

NA – Not available

ND – Not Determined

SF inh – Slope Factor – inhalation exposure

RfD inh – Reference Dose – inhalation exposure

** Toxicity Information Sources: Integrated Risk Information System (IRIS), Accessed April 1995; and
Health Effects Assessment Summary Tables (1994).

* RfD inhalation values are subchronic where a subchronic value existed. Chronic values were used if no subchronic values existed.

Shading indicates that a route-to-route extrapolation was used where no toxicity values existed.

Table A-4 Risk-Based Soil Preliminary Remediation Goals (PRGs) for a Child Residential Scenario – Inhalation Pathway

CHEMICAL	Toxicity Information**		PRGs	
	Carcinogenic	Noncarcinogenic*	Inhalation Exposure	
	SF inh per (mg/kg/day)	RfD inh (mg/kg/day)	Carcinogenic (mg/kg)	Noncarcinogenic (mg/kg)
1,1,1-Trichloroethane	NA	6.0E-01	ND	3.66E+03
1,1-Dichloroethene	1.2E+00	NA	3.61E-02	ND
1,1-Dichloroethane	NA	1.0E+00	ND	2.43E+03
2-Butanone	NA	3.0E-01	ND	3.42E+03
2-Hexanone	NA	NA	ND	ND
Acetone	NA	1.0E+00	ND	6.60E+03
Benzene	2.9E-02	NA	3.11E+00	ND
Bromodichloromethane	6.2E-02	2.0E-02	1.22E-01	1.29E+01
Bromoform	3.9E-03	NA	1.04E+02	ND
Carbon disulfide	NA	2.9E-03	ND	2.29E+01
Chloroform	8.1E-02	NA	9.72E-01	ND
Chloromethane	6.3E-03	NA	5.16E+00	ND
cis-1,2-Dichloroethene	NA	1.0E-01	ND	2.76E+02
Dibromochloromethane	8.4E-02	2.0E-01	3.00E+00	4.32E+03
Ethylbenzene	NA	3.0E-01	ND	3.55E+03
m- & p Xylenes	NA	3.0E-01	ND	5.11E+03
o-Xylenes	NA	3.0E-01	ND	4.29E+03
Tetrachloroethene	2.0E-03	NA	3.98E+01	ND
Toluene	NA	3.0E-01	ND	3.05E+03
trans-1,2-Dichloroethene	NA	2.0E-02	ND	1.15E+02
Trichloroethene	6.0E-03	NA	1.34E+01	ND
Vinyl chloride	3.0E-01	NA	2.65E-03	ND

NA – Not available

ND – Not Determined

SF inh – Slope Factor – inhalation exposure

RfD inh – Reference Dose – inhalation exposure

** Toxicity Information Sources: Integrated Risk Information System (IRIS), Accessed April 1995; and
Health Effects Assessment Summary Tables (1994).

* RfD inhalation values are subchronic where a subchronic value existed. Chronic values were used if no subchronic values existed.

Shading indicates that a route-to-route extrapolation was used where no toxicity values existed.

Table A-5 Risk-Based Soil Preliminary Remediation Goals (PRGs) for an Adult Biker/Walker Scenario – Inhalation Pathway

CHEMICAL	Toxicity Information**		PRGs	
	Carcinogenic	Noncarcinogenic*	Inhalation Exposure	
	SF inh per (mg/kg/day)	RfD inh (mg/kg/day)	Carcinogenic (mg/kg)	Noncarcinogenic (mg/kg)
1,1,1-Trichloroethane	NA	6.0E-01	ND	2.14E+06
1,1-Dichloroethene	1.2E+00	NA	4.21E+00	ND
1,1-Dichloroethane	NA	1.0E+00	ND	1.42E+06
2-Butanone	NA	3.0E-01	ND	2.00E+06
2-Hexanone	NA	NA	ND	ND
Acetone	NA	1.0E+00	ND	3.85E+06
Benzene	2.9E-02	NA	3.63E+02	ND
Bromodichloromethane	6.2E-02	2.0E-02	1.42E+01	7.54E+03
Bromoform	3.9E-03	NA	1.22E+04	ND
Carbon disulfide	NA	2.9E-03	ND	1.33E+04
Chloroform	8.1E-02	NA	1.13E+02	ND
Chloromethane	6.3E-03	NA	6.02E+02	ND
cis-1,2-Dichloroethene	NA	1.0E-01	ND	1.61E+05
Dibromochloromethane	6.4E-02	2.0E-01	3.50E+02	2.52E+06
Ethylbenzene	NA	3.0E-01	ND	2.07E+06
m- & p Xylenes	NA	3.0E-01	ND	2.98E+06
o-Xylenes	NA	3.0E-01	ND	2.50E+06
Tetrachloroethene	2.0E-03	NA	4.64E+03	ND
Toluene	NA	3.0E-01	ND	1.78E+06
trans-1,2-Dichloroethene	NA	2.0E-02	ND	6.73E+04
Trichloroethene	6.0E-03	NA	1.57E+03	ND
Vinyl chloride	3.0E-01	NA	3.09E-01	ND

NA – Not available

ND – Not Determined

SF inh – Slope Factor – inhalation exposure

RfD inh – Reference Dose – inhalation exposure

** Toxicity Information Sources: Integrated Risk Information System (IRIS), Accessed April 1995; and
Health Effects Assessment Summary Tables (1994).

* RfD inhalation values are subchronic where a subchronic value existed. Chronic values were used if no subchronic values existed.

Shading indicates that a route-to-route extrapolation was used where no toxicity values existed.

Table A-6 Risk-Based Soil Preliminary Remediation Goals for a Child Biker/Walker Scenario – Inhalation Pathway

CHEMICAL	Toxicity Information**		PRGs	
	Carcinogenic	Noncarcinogenic*	Inhalation Exposure	
	SF inh per (mg/kg/day)	RfD inh (mg/kg/day)	Carcinogenic (mg/kg)	Noncarcinogenic (mg/kg)
1,1,1-Trichloroethane	NA	6.0E-01	ND	4.58E+05
1,1-Dichloroethene	1.2E+00	NA	4.51E+00	ND
1,1-Dichloroethane	NA	1.0E+00	ND	3.04E+05
2-Butanone	NA	3.0E-01	ND	4.28E+05
2-Hexanone	NA	NA	ND	ND
Acetone	NA	1.0E+00	ND	8.25E+05
Benzene	2.9E-02	NA	3.89E+02	ND
Bromodichloromethane	6.2E-02	2.0E-02	1.52E+01	1.62E+03
Bromoform	3.9E-03	NA	1.30E+04	ND
Carbon disulfide	NA	2.9E-03	ND	2.86E+03
Chloroform	8.1E-02	NA	1.21E+02	ND
Chloromethane	6.3E-03	NA	6.45E+02	ND
cis-1,2-Dichloroethene	NA	1.0E-01	ND	3.45E+04
Dibromochloromethane	6.4E-02	2.0E-01	3.75E+02	5.40E+05
Ethylbenzene	NA	3.0E-01	ND	4.44E+05
m- & p Xylenes	NA	3.0E-01	ND	6.38E+05
o-Xylenes	NA	3.0E-01	ND	5.36E+05
Tetrachloroethene	2.0E-03	NA	4.97E+03	ND
Toluene	NA	3.0E-01	ND	3.82E+05
trans-1,2-Dichloroethene	NA	2.0E-02	ND	1.44E+04
Trichloroethene	6.0E-03	NA	1.68E+03	ND
Vinyl chloride	3.0E-01	NA	3.31E-01	ND

NA – Not available

ND – Not Determined

SF inh – Slope Factor – inhalation exposure

RfD inh – Reference Dose – inhalation exposure

** Toxicity Information Sources: Integrated Risk Information System (IRIS), Accessed April 1995; and

Health Effects Assessment Summary Tables (1994).

* RfD inhalation values are subchronic where a subchronic value existed. Chronic values were used if no subchronic values existed.

Shading indicates that a route-to-route extrapolation was used where no toxicity values existed.

TABLE A-7
SOIL PRELIMINARY REMEDIATION GOAL DEVELOPMENT
ON-SITE ENVIRONMENTAL SAMPLER
ORAL AND INHALATION EXPOSURE:
CHEMICAL CARCINOGENIC EFFECTS
(U.S. EPA, 1991)

$C_s = \frac{1E-06 \times BW \times AT \times 365}{(EF \times ED) [(SF_o \times 1E-06 \times IR_o) + (SF_{INH} \times IR_{INH} \times (1/VF + 1/PEF))]}$		
Parameter	Parameter Description	Parameter Value Assumption
C_s	Chemical Concentration in Soil (mg/kg)	Chemical-Specific
1E-06	Target Risk Level (unitless)	1E-06
BW	Body Weight (kg)	70 kg
AT	Averaging Time (years)	70 yr
365	Days/Year	365 days
EF	Exposure Frequency (days/year)	60 days/yr
ED	Exposure Duration	30-yr
SF_o	Oral Cancer Slope Factor (mg/kg/day) ⁻¹	Chemical-Specific
1E-06	Conversion Factor (kg/mg)	1E-06 kg/mg
IR_o	Oral Ingestion Rate (mg/day)	50 mg/day
SF_{INH}	Inhalation Cancer Slope Factor (mg/kg/day) ⁻¹	Chemical-Specific
IR_{INH}	Inhalation Intake Rate (m ³ /day)	20 m ³ /day
VF	Volatilization Factor (m ³ /kg)*	Chemical-Specific
PEF	Particulate Emission Factor (m ³ /kg)	4.63 X 10 ⁹ m ³ /kg

* Refer to Table 20 for derivation of VF

TABLE A-8
SOIL PRELIMINARY REMEDIATION GOAL DEVELOPMENT
ON-SITE ENVIRONMENTAL SAMPLER
ORAL AND INHALATION EXPOSURE:
CHEMICAL NON-CARCINOGENIC EFFECTS
(U.S. EPA, 1991)

$C_s = \frac{1.0 \times BW \times AT \times 365}{(EF \times ED) [(1/RfD_o) \times 1E-06 \times IR_o] + [(1/RfD_{INH}) \times IR_{INH} (1/VF + 1/PEF)]}$		
Parameter	Parameter Description	Parameter Value Assumption
C_s	Chemical Concentration in Soil (mg/kg)	Chemical-Specific
1.0	Target Hazard Level (unitless)	1.0
BW	Body Weight (kg)	70 kg
AT	Averaging Time (years)	25 yr
365	Days/Year	365 days
EF	Exposure Frequency (days/year)	60 days/yr
ED	Exposure Duration	30 yr
RfD_o	Oral Reference Dose (mg/kg/day)	Chemical-Specific
1E-06	Conversion Factor (kg/mg)	1E-06 kg/mg
IR_o	Oral Ingestion Rate (mg/day)	50 mg/day
RfD_{INH}	Inhalation Reference Dose (mg/kg/day)	Chemical-Specific
IR_{INH}	Inhalation Intake Rate (m ³ /day)	20 m ³ /day
VF	Volatilization Factor (m ³ /kg)*	Chemical-Specific
PEF	Particulate Emission Factor (m ³ /kg)	4.63 X 10 ⁹ m ³ /kg

* Refer to Table 20 for derivation of VF

TABLE A-9
SOIL PRELIMINARY REMEDIATION GOAL DEVELOPMENT
ON-SITE EXCAVATION WORKER
ORAL AND INHALATION EXPOSURE:
CHEMICAL CARCINOGENIC EFFECTS
(U.S. EPA, 1991)

$C_s = \frac{1E-06 \times BW \times AT \times 365}{(EF \times ED) [(SF_o \times 1E-06 \times IR_o) + (SF_{INH} \times IR_{INH} \times (1/VF + 1/PEF))]}$		
Parameter	Parameter Description	Parameter Value Assumption
C_s	Chemical Concentration in Soil (mg/kg)	Chemical-Specific
1E-06	Target Risk Level (unitless)	1E-06
BW	Body Weight (kg)	70 kg
AT	Averaging Time (years)	70 yr
365	Days/Year	365 days
EF	Exposure Frequency (days/year)	120 days/yr
ED	Exposure Duration	30 33 yr
SF_o	Oral Cancer Slope Factor (mg/kg/day) ⁻¹	Chemical-Specific
1E-06	Conversion Factor (kg/mg)	1E-06 kg/mg
IR_o	Oral Ingestion Rate (mg/day)	50 mg/day
SF_{INH}	Inhalation Cancer Slope Factor (mg/kg/day) ⁻¹	Chemical-Specific
IR_{INH}	Inhalation Intake Rate (m ³ /day)	20 m ³ /day
VF	Volatilization Factor (m ³ /kg)*	Chemical-Specific
PEF	Particulate Emission Factor (m ³ /kg)	4.63 X 10 ⁹ m ³ /kg

* Refer to Table 20 for derivation of VF

TABLE A-10
SOIL PRELIMINARY REMEDIATION GOAL DEVELOPMENT
ON-SITE EXCAVATION WORKER
ORAL AND INHALATION EXPOSURE:
CHEMICAL NON-CARCINOGENIC EFFECTS
(U.S. EPA, 1991)

$C_s = \frac{1.0 \times BW \times AT \times 365}{(EF \times ED) \left[\left(\frac{1}{RfD_o} \right) \times 1E-06 \times IR_o + \left(\frac{1}{RfD_{INH}} \right) \times IR_{INH} \left(\frac{1}{VF} + \frac{1}{PEF} \right) \right]}$		
Parameter	Parameter Description	Parameter Value Assumption
C_s	Chemical Concentration in Soil (mg/kg)	Chemical-Specific
1.0	Target Hazard Level (unitless)	1.0
BW	Body Weight (kg)	70 kg
AT	Averaging Time (years)	25 yr
365	Days/Year	365 days
EF	Exposure Frequency (days/year)	120 days/yr
ED	Exposure Duration	0.33 yr
RfD_o	Oral Reference Dose (mg/kg/day)	Chemical-Specific
1E-06	Conversion Factor (kg/mg)	1E-06 kg/mg
IR_o	Oral Ingestion Rate (mg/day)	50 mg/day
RfD_{INH}	Inhalation Reference Dose (mg/kg/day)	Chemical-Specific
IR_{INH}	Inhalation Intake Rate (m ³ /day)	20 m ³ /day
VF	Volatilization Factor (m ³ /kg)*	Chemical-Specific
PEF	Particulate Emission Factor (m ³ /kg)	4.63 X 10 ⁹ m ³ /kg

* Refer to Table 20 for derivation of VF

TABLE A-11
SOIL PRELIMINARY REMEDIATION GOAL DEVELOPMENT
OFF-SITE RESIDENTIAL ADULT RECEPTOR
INHALATION EXPOSURE:
CHEMICAL CARCINOGENIC EFFECTS
(U.S. EPA, 1991)

$C_s = \frac{1E-06 \times BW \times AT \times 365}{(EF \times ED) (SF_{INH} \times IR_{INH} \times (1/VF + 1/PEF))}$		
Parameter	Parameter Description	Parameter Value Assumption
C_s	Chemical Concentration in Soil (mg/kg)	Chemical-Specific
1E-06	Target Risk Level (unitless)	1E-06
BW	Body Weight (kg)	70 kg
AT	Averaging Time (years)	70 yr
365	Days/Year	365 days
EF	Exposure Frequency (days/year)	350 days/yr
ED	Exposure Duration	30 yr
IR_{INH}	Inhalation Intake Rate (m ³ /day)	15 m ³ /day
VF	Volatilization Factor (m ³ /kg)*	Chemical-Specific
PEF	Particulate Emission Factor (m ³ /kg)	4.63 X 10 ⁹ m ³ /kg

* Refer to Table 20 for derivation of VF

TABLE A-12
SOIL PRELIMINARY REMEDIATION GOAL DEVELOPMENT
OFF-SITE RESIDENTIAL ADULT RECEPTOR
INHALATION EXPOSURE:
CHEMICAL NON-CARCINOGENIC EFFECTS
(U.S. EPA, 1991)

$C_s = \frac{1.0 \times BW \times AT \times 365}{(EF \times ED) (1/RfD_{INH} \times IR_{INH} (1/VF + 1/PEF))}$		
Parameter	Parameter Description	Parameter Value Assumption
C_s	Chemical Concentration in Soil (mg/kg)	Chemical-Specific
1.0	Target Hazard Level (unitless)	1.0
BW	Body Weight (kg)	70 kg
AT	Averaging Time (years)	30 yr
365	Days/Year	365 days
EF	Exposure Frequency (days/year)	350 days/yr
ED	Exposure Duration	30 yr
RfD_{INH}	Inhalation Reference Dose (mg/kg/day)	Chemical-Specific
IR_{INH}	Inhalation Intake Rate (m ³ /day)	15 m ³ /day
VF	Volatilization Factor (m ³ /kg)*	Chemical-Specific
PEF	Particulate Emission Factor (m ³ /kg)	4.63 X 10 ⁹ m ³ /kg

* Refer to Table 20 for derivation of VF

TABLE A-13
SOIL PRELIMINARY REMEDIATION GOAL DEVELOPMENT
OFF-SITE RESIDENTIAL CHILD RECEPTOR
INHALATION EXPOSURE:
CHEMICAL CARCINOGENIC EFFECTS
(U.S. EPA, 1991)

$C_s = \frac{1E-06 \times BW \times AT \times 365}{(EF \times ED) (SF_{INH} \times IR_{INH} \times (1/VF + 1/PEF))}$		
Parameter	Parameter Description	Parameter Value Assumption
C_s	Chemical Concentration in Soil (mg/kg)	Chemical-Specific
1E-06	Target Risk Level (unitless)	1E-06
BW	Body Weight (kg)	15 kg
AT	Averaging Time (years)	70 yr
365	Days/Year	365 days
EF	Exposure Frequency (days/year)	350 days/yr
ED	Exposure Duration	6 yr
SF_{INH}	Inhalation Cancer Slope Factor (mg/kg/day) ⁻¹	Chemical-Specific
IR_{INH}	Inhalation Intake Rate (m ³ /day)	15 m ³ /day
VF	Volatilization Factor (m ³ /kg)*	Chemical-Specific
PEF	Particulate Emission Factor (m ³ /kg)	4.63 X 10 ⁹ m ³ /kg

* Refer to Table 20 for derivation of VF

TABLE A-14
SOIL PRELIMINARY REMEDIATION GOAL DEVELOPMENT
OFF-SITE RESIDENTIAL CHILD RECEPTOR
INHALATION EXPOSURE:
CHEMICAL NON-CARCINOGENIC EFFECTS
(U.S. EPA, 1991)

$C_s = \frac{1.0 \times BW \times AT \times 365}{(EF \times ED) ((1/RfD_{INH}) \times IR_{INH} (1/VF + 1/PEF))}$		
Parameter	Parameter Description	Parameter Value Assumption
C_s	Chemical Concentration in Soil (mg/kg)	Chemical-Specific
1.0	Target Hazard Level (unitless)	1.0
BW	Body Weight (kg)	15 kg
AT	Averaging Time (years)	6 yr
365	Days/Year	365 days
EF	Exposure Frequency (days/year)	350 days/yr
ED	Exposure Duration	6 yr
RfD_{INH}	Inhalation Reference Dose (mg/kg/day)	Chemical-Specific
IR_{INH}	Inhalation Intake Rate (m ³ /day)	15 m ³ /day
VF	Volatilization Factor (m ³ /kg)*	Chemical-Specific
PEF	Particulate Emission Factor (m ³ /kg)	4.63 X 10 ² m ³ /kg

* Refer to Table 20 for derivation of VF

TABLE A-15
SOIL PRELIMINARY REMEDIATION GOAL DEVELOPMENT
OFF-SITE ADULT BIKER/WALKER
INHALATION EXPOSURE:
CHEMICAL CARCINOGENIC EFFECTS
(U.S. EPA, 1991)

$C_s = \frac{1E-06 \times BW \times AT \times 365}{(EF \times ED) (SF_{INH} \times IR_{INH} \times (1/VF + 1/PEF))}$		
Parameter	Parameter Description	Parameter Value Assumption
C_s	Chemical Concentration in Soil (mg/kg)	Chemical-Specific
1E-06	Target Risk Level (unitless)	1E-06
BW	Body Weight (kg)	70 kg
AT	Averaging Time (years)	70 yr
365	Days/Year	365 days
EF	Exposure Frequency (days/year)	140 days/yr
ED	Exposure Duration	30 yr
SF_{INH}	Inhalation Cancer Slope Factor (mg/kg/day) ⁻¹	Chemical-Specific
IR_{INH}	Inhalation Intake Rate (m ³ /day)	20 m ³ /day
VF	Volatilization Factor (m ³ /kg)*	Chemical-Specific
PEF	Particulate Emission Factor (m ³ /kg)	4.63 X 10 ⁹ m ³ /kg

* Refer to Table 20 for derivation of VF

TABLE A-16
SOIL PRELIMINARY REMEDIATION GOAL DEVELOPMENT
OFF-SITE ADULT BIKER/WALKER
INHALATION EXPOSURE:
CHEMICAL NON-CARCINOGENIC EFFECTS
(U.S. EPA, 1991)

$C_s = \frac{1.0 \times BW \times AT \times 365}{(EF \times ED) (1/RfD_{INH} \times IR_{INH} (1/VF + 1/PEF))}$		
Parameter	Parameter Description	Parameter Value Assumption
C_s	Chemical Concentration in Soil (mg/kg)	Chemical-Specific
1.0	Target Hazard Level (unitless)	1.0
BW	Body Weight (kg)	70 kg
AT	Averaging Time (years)	30 yr
365	Days/Year	365 days
EF	Exposure Frequency (days/year)	140 days/yr
ED	Exposure Duration	30 yr
RfD_{INH}	Inhalation Reference Dose (mg/kg/day)	Chemical-Specific
IR_{INH}	Inhalation Intake Rate (m ³ /day)	20 m ³ /day
VF	Volatilization Factor (m ³ /kg)*	Chemical-Specific
PEF	Particulate Emission Factor (m ³ /kg)	4.63 X 10 ⁹ m ³ /kg

* Refer to Table 20 for derivation of VF

TABLE A-17
SOIL PRELIMINARY REMEDIATION GOAL DEVELOPMENT
OFF-SITE CHILD BIKER/WALKER
INHALATION EXPOSURE:
CHEMICAL CARCINOGENIC EFFECTS
(U.S. EPA, 1991)

$C_s = \frac{1E-06 \times BW \times AT \times 365}{(EF \times ED) (SF_{INH} \times IR_{INH} \times (1/VF + 1/PEF))}$		
Parameter	Parameter Description	Parameter Value Assumption
C_s	Chemical Concentration in Soil (mg/kg)	Chemical-Specific
1E-06	Target Risk Level (unitless)	1E-06
BW	Body Weight (kg)	15 kg
AT	Averaging Time (years)	70 yr
365	Days/Year	365 days
EF	Exposure Frequency (days/year)	140 days/yr
ED	Exposure Duration	6 yr
SF_{INH}	Inhalation Cancer Slope Factor (mg/kg/day) ⁻¹	Chemical-Specific
IR_{INH}	Inhalation Intake Rate (m ³ /day)	20 m ³ /day
VF	Volatilization Factor (m ³ /kg)*	Chemical-Specific
PEF	Particulate Emission Factor (m ³ /kg)	4.63 X 10 ⁹ m ³ /kg

* Refer to Table 20 for derivation of VF

TABLE A-18
SOIL PRELIMINARY REMEDIATION GOAL DEVELOPMENT
OFF-SITE CHILD BIKER/WALKER
INHALATION EXPOSURE:
CHEMICAL NON-CARCINOGENIC EFFECTS
(U.S. EPA, 1991)

$C_s = \frac{1.0 \times BW \times AT \times 365}{(EF \times ED) (1/RfD_{INH} \times IR_{INH} (1/VF + 1/PEF))}$		
Parameter	Parameter Description	Parameter Value Assumption
C_s	Chemical Concentration in Soil (mg/kg)	Chemical-Specific
1.0	Target Hazard Level (unitless)	1.0
BW	Body Weight (kg)	15 kg
AT	Averaging Time (years)	6 yr
365	Days/Year	365 days
EF	Exposure Frequency (days/year)	140 days/yr
ED	Exposure Duration	6 yr
RfD_{INH}	Inhalation Reference Dose (mg/kg/day)	Chemical-Specific
IR_{INH}	Inhalation Intake Rate (m ³ /day)	20 m ³ /day
VF	Volatilization Factor (m ³ /kg)*	Chemical-Specific
PEF	Particulate Emission Factor (m ³ /kg)	4.63 X 10 ⁹ m ³ /kg

* Refer to Table 20 for derivation of VF

Table A-19 Summary of Volatilization Factor Parameters for Granville Solvents (a)

Chemical	Thera	beta	ds	Kas	T	DI (b)	H (b)	Kd	Koc (b)	OC	Pt	Pa	Del	alpha	LS	V	DH	A	Pi	VF	1/VF
1,1,1-Trichloroethane	0.1	1.5	2.65	0.499	7.9E+08	0.078	1.72E-02	1.4125	141.25	0.01	0.433962	0.284	0.0063	0.000435	45	2.25	2	2.03E+07	3.14	5.9E+03	1.71E-04
1,1-dichloroethene	0.1	1.5	2.65	0.952	7.9E+08	0.104	1.50E-02	0.6457	64.57	0.01	0.433962	0.284	0.0083	0.001041	45	2.25	2	2.03E+07	3.14	3.6E+03	2.81E-04
1,1-Dichloroethane	0.1	1.5	2.65	2.091	7.9E+08	0.096	1.54E-02	0.302	30.2	0.01	0.433962	0.284	0.0077	0.001836	45	2.25	2	2.03E+07	3.14	2.3E+03	4.29E-04
2-Butanone	0.1	1.5	2.65	0.145	7.9E+08	0.0808	4.35E-05	0.0123	1.23	0.01	0.433962	0.284	0.0065	0.000137	45	2.25	2	2.03E+07	3.14	1.1E+04	9.14E-05
2-Hexanone	0.1	1.5	2.65	0.001	7.9E+08	0.078	4.35E-05	1.349	134.9	0.01	0.433962	0.284	0.0063	0.000001	45	2.25	2	2.03E+07	3.14	1.2E+05	8.48E-06
Acetone	0.1	1.5	2.65	0.277	7.9E+08	0.124	2.50E-05	0.0037	0.37	0.01	0.433962	0.284	0.0100	0.000396	45	2.25	2	2.03E+07	3.14	6.3E+03	1.58E-04
Benzene	0.1	1.5	2.65	0.284	7.9E+08	0.088	5.50E-03	0.7943	79.43	0.01	0.433962	0.284	0.0071	0.000287	45	2.25	2	2.03E+07	3.14	7.4E+03	1.35E-04
Bromodichloromethane	0.1	1.5	2.65	13.631	7.9E+08	0.09	2.05E-01	0.6166	61.66	0.01	0.433962	0.284	0.0072	0.004846	45	2.25	2	2.03E+07	3.14	6.2E+02	1.61E-03
Bromoform	0.1	1.5	2.65	0.015	7.9E+08	0.083	6.84E-04	1.8197	181.97	0.01	0.433962	0.284	0.0067	0.000015	45	2.25	2	2.03E+07	3.14	3.3E+04	2.99E-05
Carbon disulfide	0.1	1.5	2.65	0.233	7.9E+08	0.104	1.68E-02	2.9512	295.12	0.01	0.433962	0.284	0.0083	0.000281	45	2.25	2	2.03E+07	3.14	7.6E+03	1.32E-04
Chloroform	0.1	1.5	2.65	0.315	7.9E+08	0.104	3.39E-03	0.4416	44.16	0.01	0.433962	0.284	0.0083	0.000375	45	2.25	2	2.03E+07	3.14	6.5E+03	1.55E-04
Chloromethane	0.1	1.5	2.65	1.329	7.9E+08	0.126	8.14E-03	0.2512	25.12	0.01	0.433962	0.284	0.0101	0.001677	45	2.25	2	2.03E+07	3.14	2.7E+03	3.74E-04
cis-1,2-Dichloroethene	0.1	1.5	2.65	1.647	7.9E+08	0.1	3.19E-02	0.7943	79.43	0.01	0.433962	0.284	0.0080	0.001586	45	2.25	2	2.03E+07	3.14	2.6E+03	3.78E-04
Dibromochloromethane	0.1	1.5	2.65	0.039	7.9E+08	0.086	7.83E-04	0.8318	83.18	0.01	0.433962	0.284	0.0069	0.000039	45	2.25	2	2.03E+07	3.14	2.1E+04	4.82E-05
Ethylbenzene	0.1	1.5	2.65	0.145	7.9E+08	0.075	6.44E-03	1.8197	181.97	0.01	0.433962	0.284	0.0060	0.000127	45	2.25	2	2.03E+07	3.14	1.1E+04	8.81E-05
m & p-Xylenes	0.1	1.5	2.65	0.069	7.9E+08	0.077	6.27E-03	3.7154	371.54	0.01	0.433962	0.284	0.0062	0.000063	45	2.25	2	2.03E+07	3.14	1.6E+04	6.13E-05
o-Xylenes	0.1	1.5	2.65	0.098	7.9E+08	0.077	6.27E-03	2.6303	263.03	0.01	0.433962	0.284	0.0062	0.000089	45	2.25	2	2.03E+07	3.14	1.4E+04	7.30E-05
Tetrachloroethene	0.1	1.5	2.65	0.438	7.9E+08	0.072	2.90E-02	2.7164	271.64	0.01	0.433962	0.284	0.0058	0.000355	45	2.25	2	2.03E+07	3.14	6.5E+03	1.53E-04
Toluene	0.1	1.5	2.65	0.169	7.9E+08	0.087	6.68E-03	1.6218	162.18	0.01	0.433962	0.284	0.0070	0.000172	45	2.25	2	2.03E+07	3.14	9.8E+03	1.02E-04
trans-1,2-Dichloroethene	0.1	1.5	2.65	0.440	7.9E+08	0.1	6.32E-03	0.5888	58.88	0.01	0.433962	0.284	0.0080	0.000495	45	2.25	2	2.03E+07	3.14	5.5E+03	1.81E-04
Trichloroethene	0.1	1.5	2.65	0.391	7.9E+08	0.079	9.10E-03	0.955	95.5	0.01	0.433962	0.284	0.0063	0.000350	45	2.25	2	2.03E+07	3.14	6.6E+03	1.51E-04
Vinyl chloride	0.1	1.5	2.65	142.24	7.9E+08	0.106	8.50E-02	0.0245	2.45	0.01	0.433962	0.284	0.0085	0.008124	45	2.25	2	2.03E+07	3.14	6.5E+01	1.53E-02

(a) Volatilization factor derived per U.S. EPA Human Health Evaluation Manual, Part B: "Development of Risk-Based Preliminary Remediation Goals" (Dec 1991) and a memo from Janine Dinan to Regional Toxic Integration Coordinators about changes to equations in the Part B Guidance, dated November 1992.

(b) PDER, 1990. Pennsylvania Department of Environmental Resources, "User's Manual for Risk Assessment and Transport (RAFT) Modeling System" July 13, 1990

Table A-20 Summary of Protective Soil Levels Based on Soil to Groundwater Migration – U.S. EPA MCL

$$\text{Soil level} = \text{Koc} \times \text{organic content} \times \text{MCL} \times \text{DAF}$$

	Koc (L/kg) (a)	organic content	U.S. EPA MCL (ug/L) (b)	Estimated MCLG (ug/L) (c)	soil level DAF = 10 (ug/kg)
1,1,1-trichloroethane	141.25	0.01	200	–	2825.08
1,1-dichloroethene	64.57	0.01	7	–	45.20
1,1-dichloroethane	30.20	0.01	–	700	2113.97
2-butanone	1.23	0.01	–	4200	516.71
2-hexanone	134.90	0.01	–	–	ND
acetone	0.37	0.01	–	700	26.01
benzene	79.43	0.01	5	–	39.72
bromodichloromethane	61.66	0.01	100	–	616.60
bromoform	181.97	0.01	100	–	1819.70
carbon disulfide	295.12	0.01	–	700	20658.46
chloroform	44.16	0.01	100	–	441.57
chloromethane	25.12	0.01	–	44.1	110.77
cis-1,2-dichloroethene	79.43	0.01	70	–	556.03
dibromochloromethane	83.18	0.01	100	–	831.76
ethylbenzene	181.97	0.01	700	–	12737.91
m- & p-xylene	371.54	0.01	10000	–	371535.23
o-xylene	263.03	0.01	10000	–	263026.80
tetrachloroethene	271.64	0.01	5	–	135.82
toluene	162.18	0.01	1000	–	16218.10
trans-1,2-dichloroethene	58.88	0.01	100	–	588.84
trichloroethene	95.50	0.01	5	–	47.75
vinyl chloride	2.45	0.01	2	–	0.49

DAF – Dilution and Attenuation Factor based on the U.S.EPA DAF of 10

ND – Not Determined

NL – Not Listed

Sources:

- (a) PDER. 1990. Pennsylvania Department of Environmental Resources.
"User's Manual for Risk Assessment and Transport (RAFT) Modeling System"
July 13, 1990.
Pollution Engineering. 1992. "Data Compilation for Soil Sorption Coefficients"
June 15, 1992.
- (b) U.S. EPA. 1994. Drinking Water Regulations and Health Advisories. Office
of Water. November 1994.
- (c) An MCLG was estimated for those chemicals without MCLs

Table A-21 Summary of Protective Soil Levels Based on Soil to Groundwater Migration – Region IX PRG

$$\text{Soil level} = K_{oc} \times \text{organic content} \times \text{MCL} \times \text{DAF}$$

	Koc (L/kg) (a)	organic content	U.S. EPA Region IX PRG (ug/L) (b)	soil level DAF = 10 (ug/kg)
1,1,1-trichloroethane	141.25	0.01	1300	18362.99
1,1-dichloroethene	64.57	0.01	0.046	0.30
1,1-dichloroethane	30.20	0.01	810	2446.16
2-butanone	1.23	0.01	1900	233.75
2-hexanone	134.90	0.01	NL	ND
acetone	0.37	0.01	610	22.66
benzene	79.43	0.01	0.39	3.10
bromodichloromethane	61.66	0.01	0.18	1.11
bromoform	181.97	0.01	8.5	154.67
carbon disulfide	295.12	0.01	21	619.75
chloroform	44.16	0.01	0.16	0.71
chloromethane	25.12	0.01	1.5	3.77
cis-1,2-dichloroethene	79.43	0.01	61	484.54
dibromochloromethane	83.18	0.01	1	8.32
ethylbenzene	181.97	0.01	1300	23656.11
m- & p-xylene	371.54	0.01	1400	52014.93
o-xylene	263.03	0.01	1400	36823.75
tetrachloroethene	271.64	0.01	1.1	29.88
toluene	162.18	0.01	720	11677.03
trans-1,2-dichloroethene	58.88	0.01	120	706.61
trichloroethene	95.50	0.01	1.6	15.28
vinyl chloride	2.45	0.01	0.02	0.005

DAF – Dilution and Attenuation Factor based on the U.S.EPA DAF of 10

ND – Not Determined because a PRG for this chemical has not been derived.

NL – Not Listed

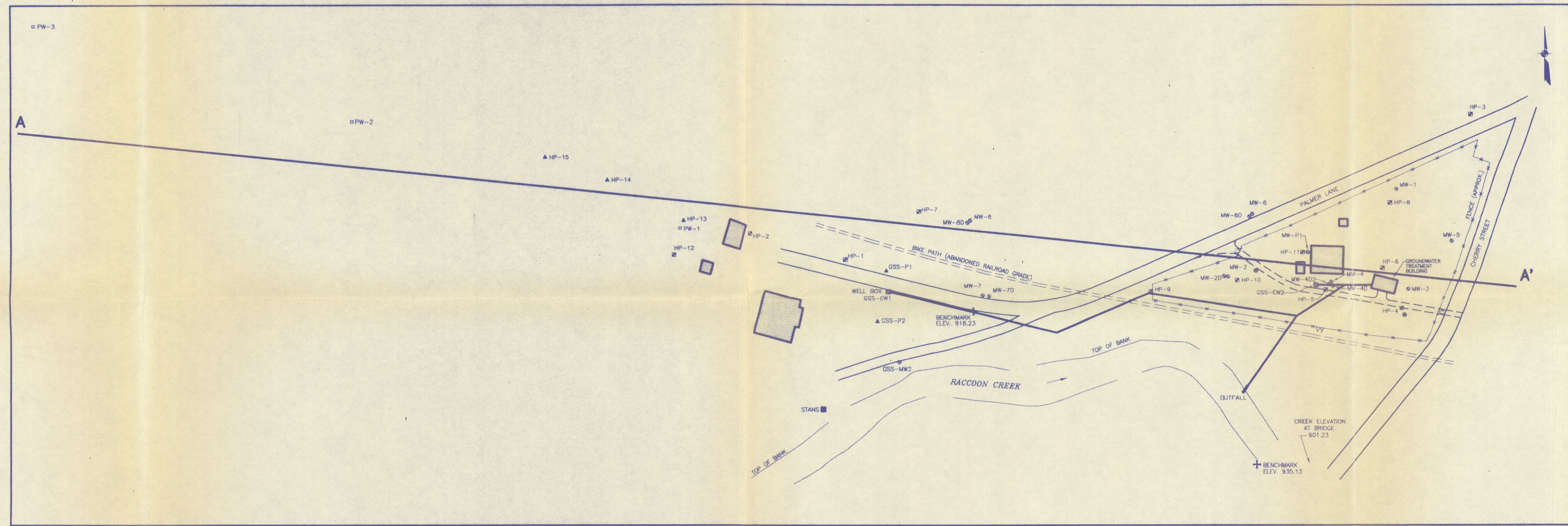
Sources:

(a) PDER. 1990. Pennsylvania Department of Environmental Resources.

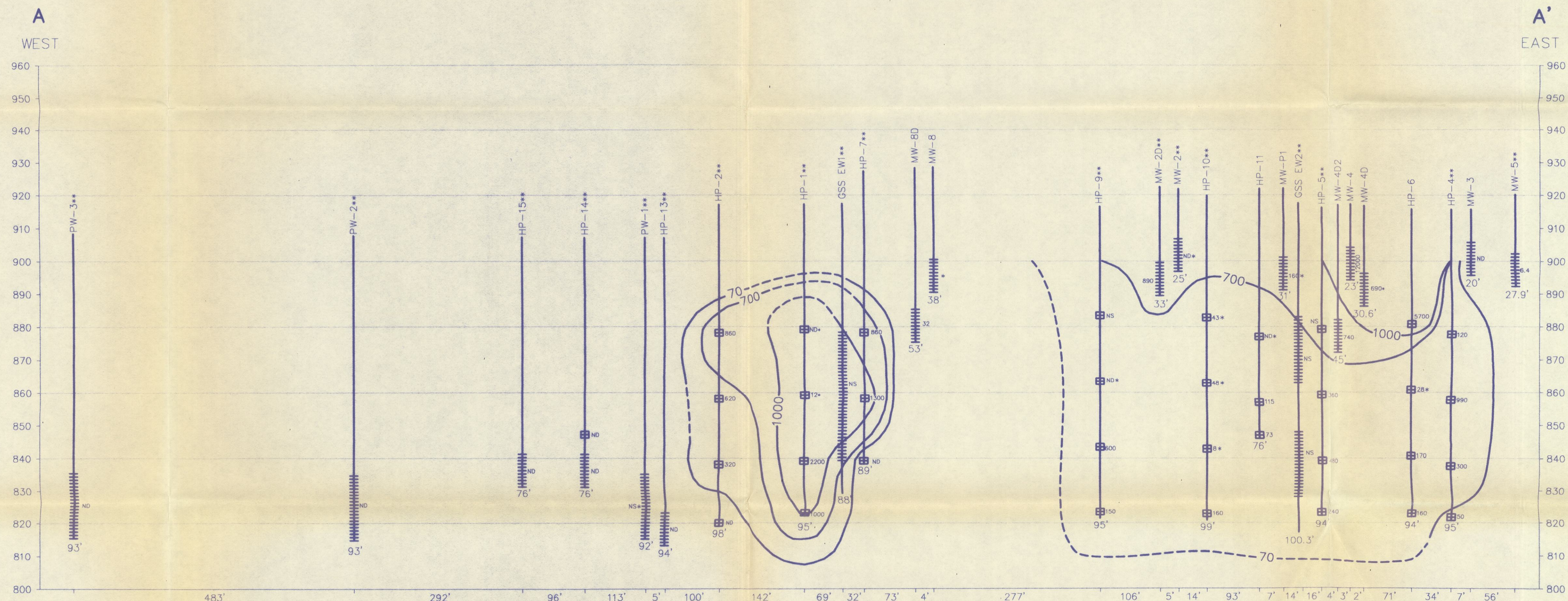
"User's Manual for Risk Assessment and Transport (RAFT) Modeling System"
July 13, 1990.

Pollution Engineering. 1992. "Data Compilation for Soil Sorption Coefficients"
June 15, 1992.

(b) U.S. EPA, Region IX. 1995 EPA Region IX Preliminary Remediation Goals (dated 02/01/95).



BASE MAP
SCALE: 1" = 100'



DEPTH PROFILE
HORIZONTAL SCALE: APPROX. 1"=100'
VERTICAL SCALE: 1"=20'

WELL LOCATIONS ADJUSTED FOR ILLUSTRATION PURPOSES

EXPLANATION

- DEPTH WHERE WATER SAMPLE COLLECTED
- WELL SCREEN LENGTH
- TOTAL DEPTH OF WELL OR BOREHOLE BELOW GROUND SURFACE
- ND NON DETECT
- NS NOT SAMPLED AT THAT DEPTH
- ppb PARTS PER BILLION
- * POINT NOT USED IN DEPTH PROFILE
- ** WELLS PROJECTED IN TO THE CROSS SECTION

--- 5ppb ISO CONCENTRATION LINES
DASHED WHERE INFERRED

NOTE: CONTOUR INTERVALS FOR ILLUSTRATION PURPOSES.

0	6/12/95	TPF/CAP	TS	ORIGINAL	DRAWN BY	TPF	M&E Metcalf & Eddy 2800 CORPORATE EXCHANGE DR., SUITE 250 COLUMBUS, OHIO 43231 PHONE: (614) 890-5501	SCALE: AS NOTED ABOVE UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION	GRANVILLE SOLVENTS SITE DEPTH PROFILE OF ACETONE CONCENTRATIONS ALONG CROSS SECTION LINE A - A' GRANVILLE, OHIO	JOB 016688-0011-011 FILE NO. WSELEV17 FIGURE 8
					DEPT. CHECK					
NUMBER	DATE	MADE BY	CHECKED BY	DESCRIPTION	PROJ. CHECK					
REVISIONS										